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The mission of the Orthopaedic Section of the American Physical Therapy Association is to be the leading advocate and resource for the practice of Orthopaedic Physical Therapy. The Section will serve its members by fostering quality patient/client care and promoting professional growth through:

- enhancement of clinical practice,
- advancement of education, and
- facilitation of quality research.

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Evidence-based Practice in Physical Therapy: Let's Choose Wisely

In his book *Collapse: How Societies Choose to Fail or Succeed,* Jared Diamond writes that one of the primary reasons for the collapse of past societies is due to difficult choices which they failed to make, namely, failing to realize which core values were worth maintaining and which required changing to meet new challenges. Thomas L. Friedman makes the argument in *the World Is Flat: A Brief History of the Twenty-first Century* that the same fate awaits companies who fail to innovate and reinvent themselves. Could a profession (or at least a profession's long-term 'vision' for itself) be in the same peril if it does not similarly adapt?

One of the earliest citations in the physical therapy literature using the term "evidence-based practice (EBP)" is from an editorial written 10 years ago by Jules Rothstein who wrote about the need to develop "irrefutable evidence of the benefits we offered."[1] He anticipated potential difficulty in undergoing a fundamental change that would truly transform physical therapy to an evidence-based profession. Even when a greater body of evidence was established, he questioned if practitioners would use this evidence. Otherwise stated, would the profession of physical therapy choose to succeed by changing our practice patterns and successfully integrating evidence into our profession?

Where do we stand on this journey? What have been our choices to date? Steven George's recent editorial provided a glimpse as to where we stand in this process via student cited barriers to EBP.[2] He noted that in teaching an EBP course sequence his students reported that an evidence-based model of clinical practice was often not the norm and listed student identified barriers for translating EBP from the lecture hall to the clinic.

Some of these student cited barriers were those which Dr. Rothstein worried about in his August 1997 editorial. These were the unwillingness to change entrenched practice patterns which relied on unsubstantiated examination and treatment options, not critically reviewing the literature, and relying solely on traditional continuing education models. Dr. George conceded these student reports represented "low level evidence" based purely on anecdotal experiences from a single academic setting. However, based on these reports, the prevalence of practices which advertise unsubstantiated interventions and the continued existence of continuing education courses taught by the self-described experts who fail to support his/her theories with data, we know that this type of practice does still exist. Criticism of those who would continue to practice in this way is well deserved. However the larger question may be, "how prevalent is this type of practice?" Or how much do these barriers account for failure to incorporate evidence-based practice?

I wonder if this is a shrinking minority. Physical therapists generally agree that EBP is necessary, that literature is useful to practice and helps in decision making.[3] These attitudes and beliefs reflect a group that does use or, at least, desires to use EBP. A large portion of therapists also report that they were interested in improving their skills and incorporating evidence into practice. This leads one to believe that if clinicians are not adequately modeling EBP then perhaps there are reasons other than 'unwillingness' that might explain this failure.

Indeed many of the other student cited barriers were related to therapists' 'ability' and not willingness. Among other barriers reported by Dr. Georges' students are lack of understanding of common statistical estimates used to report clinical data (ie, number needed to treat, odds ratio, etc.), unfamiliarity for what compromises a 'quality' study, lack of awareness as to what weight clinical experience should carry in the triumvirate EBP model, inability to formulate answerable clinical questions or efficiently search online databases. In actuality many of these barriers are similar to those theorized by other authors[4] or reported by therapists themselves.[3] Consider, in a survey of therapists, a minority of therapists surveyed feel like they completely understood specific terms related to EBP and only slightly more than half surveyed reported confidence in their appraisal skills. Perhaps these 'ability' factors are a greater contributor of the failure to adequately incorporate an evidence base into ones practice.

If there is a dearth in evidence-based practice in our clinics and it is true that ability explains much of this deficit, this is indeed a matter for concern or as Dr. George stated, "…nothing will impede our progress toward Vision 2020 more than a group of students having evidence-based practice inadequately modeled in clinical settings." Similarly stated this could also read, nothing will impede our progress toward Vision 2020 more than a group of clinicians being *unable* to adequately model evidence-based practice in our clinical settings. This highlights the need to not only ensure optimal educational experiences for our next generation of therapists but also to establish optimal evidence-based training *and* implementation strategies for *all* therapists.

Indeed it is probably those therapists who are not recent graduates who are in most need of such interventions. Surveys of therapists show that "positive beliefs were more likely among younger respondents than those who were older or those or had been licensed longer." It does not seem that surprising to me that someone who received intensive primary instruction in this type of practice in his/her respective physical therapy program is more proficient in it than someone who has tried to 'learn as they go.'

Physical therapy is not alone in this 'generation gap.' A recent systematic review of the relationship between clinical experience and quality of health care concluded that physicians who have been in practice longer may be at risk for providing lower quality of care. They suggest that their findings may be the result of substantial environmental

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changes occurring recently in medicine such as the adoption of evidence-based medicine and quality assurance techniques. They stated that more experienced therapists may have less familiarity with these strategies and may be less accepting of them. This is an intriguing suggestion in light of traditional thought that generally viewed a more experienced practitioner as more likely to have greater expertise and thus better outcomes. Perhaps recent environmental changes (ushered in and accelerated by advances in information technology) has not only leveled this playing field but, at least temporarily, flipped it.

So a chief question is, "HOW can we best enable therapists and particularly our more veteran clinicians, to be evidence-based practitioners?" Certainly much has been written on EBP over the last decade and therapists have repeatedly been urged to update their practice. It would seem apparent that this alone is inadequate in significantly altering physical therapy practice. There are many other potential solutions, a few offered by Dr George. Utilization of the tDPT and an evidence-based module as part of the APTA CI credentialing program are certainly viable options. Interestingly there is also mention of clinicians and students solving problems by bringing together their collective strengths of clinical experience and EBP respectively. Effectively this would make the problem part of the solution.

I would suggest that additional strategies address what therapists report as their primary barrier--time. Truly, are we even sure what is meant by this time barrier? After all one of the purported benefits of EBP is that due to the immense amount of clinical information available today it is impossible to find the time to read all new information and 'stay up to date.' This problem gave weight to the idea of asking a specific answerable question. So what do therapists mean by time? If it is the time to formulate a question, do a search, appraise the research, and come up with an answer, then strategies to make these steps more efficient are appropriate. Perhaps though clinicians are referring to the time it takes to learn and infuse a new skill or method of practice. Then educational efforts to teach this new skill would be more appropriate to address this reported barrier.

Regardless, I believe that clinicians need to be able to better use the innovations of the 'flat world platform' that our researchers in physical therapy have used to such obvious advantage in recent years. One need only to look at the production rate born of collaborative efforts from investigators (not only across our nation but from all 4 corners of the world) to see how empowering these innovations can be. The ability to reach all therapists in ways that help them to overcome what they have reported to be their chief barrier – time restraints – could go a long way in closing our EBP gap.

With these issues in mind, I will make 2 additional proposals. First, I propose the addition of an evidence-based page to the APTA website that would stand as an ongoing educational resource in learning and integrating EBP as well as a launching point for all searches. There would be a prominent link (perhaps displayed in the spaces currently reserved for announcing upcoming conferences or legislation) to the EBP page available to all therapists, both members and nonmembers. Here would be offered free course work in EBP such as that offered to student therapists today – an EBP 101 if you will. The self-paced nature and on demand access to this course would help to address one aspect of the reported time barrier. There would also be advanced course offerings and an evidence-based toolbox with a glossary of terms. Initially there would be links to Pub Med, Cochrane, Pedro, Hooked on Evidence, Open Door, etc with a long-term goal of being able to launch a simple search that would generate hits from all of these resources on one page. This type of one stop shopping will be more time efficient for the practicing clinician.

Secondly, I propose better use of the ability to deliver audio content via the internet. It has been reported that the average commute to work is 25 minutes. Perhaps here therapists can find time to further close this gap. In addition to free audio offerings about the process of EBP, we could also have podcasts available for download including journal editorials, the bottom line, invited commentary and author response, selected clinical consults with "What would *you* do?" type summaries, and open debate on what practice "*should* look like" framed in the 'current' state of the literature. This audio option may also effectively target the 'time barrier.'

"Disseminating innovations is a challenge known to many human enterprises," says Alan Jette.[6] Indeed I would suggest that this may be the crux of the perceived failure to adequately adopt EBP throughout our profession. Perhaps we need a better understanding of where we truly are in this process. Jette also suggests that scientists and academics must take the science of diffusing innovations just as seriously as they take the science of producing innovations. It is also equally important that clinicians share this burden, and it would seem altogether appropriate, as Dr George recommends, stepping up our dialogue in this matter. Clinicians, who bear the ultimate responsibility in integrating evidence into their practice, need to redouble their efforts. After all, it is incumbent on our physical therapy clinicians to 'do their part' and use the evidence.

In short, I believe that, as a whole, we have made wise choices about both the future direction for the profession of physical therapy and the steps needed to achieve this vision. However it would appear that we, on some level, have a 'diffusion' problem[6] with regards to EBP that may stand as a potential obstacle in fully achieving this vision. We may make great strides in overcoming this problem by addressing the biggest part of this issue and ensuring that practicing clinicians who are pressed for time due to clinical obligations (not to mention their 'outside' responsibilities in the community and their household), have the best tools to effectively and efficiently 'learn EBP' and 'use the evidence.' Will we make the choices necessary to overcome our EBP diffusion problem? Will we continue to choose wisely?

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president's corner

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In this issue of *Orthopaedic Physical Therapy Practice,* you will find the Orthopaedic Section 2007 – 2009 Strategic Plan (page 106). This plan was developed at the Fall Board Meeting in October 2006 with the input from members of the Board of Directors, Committee Chairs, and Special Interest Group Leadership. After review and revision, the Strategic Plan was officially approved by the Section Leadership on April 18, 2007. The Strategic Plan will provide the Section with a plan to focus its efforts and financial resources over the next 3 years. To ensure that the goals and objectives are reached, Section leadership will continually review the plan and use it as a benchmark to guide the Section through the next 3 years.

Without rehashing the Strategic Plan in detail, I would like to take this opportunity to highlight some of the key initiatives the Section will be undertaking over the next 3 years.

- In 2006 the Section initiated the development of practice guidelines for management of musculoskeletal conditions that are commonly treated by orthopaedic physical therapists using the framework of the International Classification for Functioning and Disability. In the next 3 years, the Section will continue to develop, refine, update, and disseminate the guidelines for review and use. These evidence-based treatment guidelines will be used to advance orthopaedic physical therapist practice, guide professional and post-professional education, and establish an agenda for future clinical research.
- The Section will continue efforts to foster development and expansion of orthopaedic physical therapy residency and fellowship programs by developing and disseminating educational materials to support the didactic component of residency and fellowship programs. This will include development of targeted Independent Study Courses and programming at meetings sponsored by the Section. To facilitate the growth of programs, the Section will also provide programming to develop faculty for residency and fellowship programs.
- To foster research, the Section is developing a research endowment that will provide ongoing financial support for grants awarded by the Section. Additionally the Section will establish a Task Force to identify future research initiatives that should be supported by the Section.
- The Section will begin to investigate the feasibility of an annual Orthopaedic Section Meeting that will provide additional continuing education opportunities for our members. The purpose of this meeting will be to complement, not compete with, the programming at the Combined Sections Meeting. The programming at our annual meeting will include opportunities to enhance manual therapy psychomotor skills, increased programming opportunities for the Special Interest Groups and educational activities to support the development of orthopaedic residencies and fellowship programs.
- The Section will promote and advocate for the orthopaedic physical therapist as the practitioner of choice of the prevention and treatment of musculoskeletal conditions. This will include developing multiple media that promote the orthopaedic physical therapist as the practitioner of choice for musculoskeletal conditions. Together with APTA and other Sections, chapters, and organizations the Section will promote the orthopaedic physical therapist to the public, consumers, physicians, other health care providers, regulatory agencies, legislators, and payors.
- To understand the needs of our members, from time to time the Section will conduct a member survey via e-mail. The purpose of these surveys will be to obtain input and suggestions from the membership, identify members willing to increase their involvement in the Section, and to assess the best methods of communication with the members. When you receive these surveys, we encourage you to take the time to respond. The information that you provide is invaluable to the Section leadership.
- To encourage greater participation from members, the Section will develop and maintain an active pool of individuals that are willing to serve in leadership positions and will establish a network of mentors to provide mentorship for individuals in the membership pool. We encourage everyone that is interested in getting involved with the Section to contact the Section office.

The Section Leadership believes that the plan outlines an exciting and challenging roadmap for the Section over the next 3 years. I would like to encourage you to review the Strategic Plan in detail and to provide comments and suggestions to the Orthopaedic Section office.

A Hypothesis-oriented Algorithm for Symptom-based Diagnosis by Physical Therapists: Description and Case Series

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ABSTRACT

Study Design: Case series. **Subjects:** Two patients referred to physical therapy with a diagnosis of lower back pain (LBP). **Background:** The increasing role of physical therapists in primary care settings highlights the skills needed to determine the appropriateness of physical therapy for patients. A hypothesis-oriented algorithm for symptom-based diagnosis was developed for use by physical therapists. The goal of this process is to determine a diagnostic impression to guide decisions regarding patient disposition and physical therapist management. This case series demonstrates the process in two individuals with LBP referred to a community-based outpatient physical therapy clinic. **Diagnosis:** Despite the fact that both patients presented to physical therapy with a similar referral diagnosis, the hypothesis-oriented algorithm revealed a difference in diagnostic impressions formed by the physical therapist, and resulted in divergent decisions regarding the appropriateness of physical therapy between patients. Clinical findings based on the hypothesis-oriented algorithm directed treatment and case management. **Discussion:** A symptom-based diagnostic process was used to determine the appropriateness of physical therapy for the patients described in this case series. The described approach is intended to provide physical therapists with a process to arrive at a diagnostic impression regarding the pathology underlying patients' presentations, in order to determine the appropriate disposition and treatment for individuals presenting to physical therapy. Additional research will assist in validating this approach and assess its effectiveness to prepare student physical therapists in entry-level, postprofessional, and residency programs.

Key Words: differential diagnosis, direct access, low back pain, primary care

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BACKGROUND

Lower back pain (LBP) is a common symptom that causes significant disablement in the form of economic loss,[1] psychological and interpersonal difficulties,[2] and emotional distress.[3] As a result, patients with LBP frequently seek physical therapy management. Many different conditions cause LBP. Some forms of pathology that cause LBP are amenable to physical therapist intervention, while it is ineffective at best and dangerous at worst for other forms of pathology. Therefore, physical therapists' primary responsibility is to determine the appropriateness of physical therapy for patients, which involves deciding whether to treat the patient, refer the patient for additional testing or treatment by another health care provider, or initiate both treatment and referral simultaneously. Such a decision depends on physical therapists' ability to identify the pathology underlying patients' clinical presentations through a diagnostic process. However, a review of the current literature revealed no papers describing a systematic process for symptom-based diagnosis by physical therapists.

Diagnostic reasoning is recognized as a component of clinical reasoning by expert physical therapists. It involves the "formation of a diagnosis related to physical disability and impairment with consideration of associated pain mechanisms, tissue pathology, and the broad scope of potential contributing factors."[4(p 322)] As with all their clinical reasoning strategies, master clinicians appear to optimize clinical efficiency by attending to cues provided by patients rather than following uniform protocols. This generally involves interplay between pattern recognition and clinical hypothesis testing.[4] Similarly, an efficient system for symptom-based diagnosis for physical therapists appears to require these properties.

One of us (HGW) developed a hypothesis-oriented algorithm to determine a diagnostic impression upon which to base decisions regarding appropriate patient disposition and treatment (Table 1), which we have used to instruct students in entry-level, postprofessional, and Orthopaedic Residency programs since 1999. First, the patient's chief concern is identified. *Yellow Flags* are then identified. These previously have been characterized as psychosocial correlates of prognosis in individuals with persistent pain.[5] In the context of this diagnostic process, *Yellow Flags* indicate possible obstructions to proper communication between a patient and physical therapist. Examples include language, culture, age, and gender differences between the patient and physical therapist. Although they do not imply the presence of a dangerous disease, *Yellow Flags* are similarly important because they may compromise optimal clinical decisions. Yellow Flags are considered early in the diagnostic process to clarify potential biases near the beginning of information gathering. Next, *Red Flag* features of the case are identified. Traditionally, Red Flag findings have been considered pathognomic of various health

Table 1. Hypothesis-Oriented Algorithm for Symptom-Based Diagnosis by Physical Therapists

Identify patient's chief concern
Identify Yellow and Red Flags
Create a timeline of the chief concern
Consider all forms of pathology: Remote and Local Sort pathology by likelihood from epidemiology (eg, age, sex, and geography)
Ask diagnostically focused questions Re-sort possible pathology according to likelihood based on patient's response
Perform objective exam maneuvers in order of importance Re-sort possible pathology based on patient's response to testing
Form diagnostic impression
Determine appropriate patient disposition • Refer for additional testing and treatment • Initiate physical therapy intervention • Initiate both treatment and referral
Determine appropriate treatment

conditions that require an immediate referral to another health care provider.[6] However, recent evidence suggests these findings may be too nonspecific for use in this manner. Therefore, we define *Red Flags* as features of a specific patient's problem that raise the index of suspicion about one condition over the others. For example, a history of cigarette smoking in a patient with shoulder pain is a Red Flag for possible apical lung tumor. While cigarette smoking is widely considered a serious health risk, it typically is not included with traditional Red Flag symptoms and signs.

A timeline of the patient's chief concern is then created to recognize potentially relevant temporal relationships between a patient's disablement and significant events. The timeline may help rule less or more likely some of the possible causes. The timeline should include the onset of current symptoms, previous episodes of similar symptoms, symptom progression, timing and outcomes of previous treatments, diagnostic tests, and past medical history that may contribute to the current chief concern (eg, diagnosis of diabetes mellitus).

All possible forms of pathology that could cause the patient's chief concern are then considered. The mnemonic *TIM VaDeTuCoNe* was developed to represent the major categories of pathology, including Trauma, Inflammation, Metabolic, Vascular, Degenerative, Tumor, Congenital, and Neurogenic/Psychogenic. Some conditions fail to fit simply into one diagnostic category, so there may be some diversity of classification among clinicians. The important function of *TIM VaDeTuCoNe* is to help physical therapists consider the wide range of possible pathologies that may contribute to the patient's chief concern while constructing a diagnostic hypothesis list, regardless of individual preferences in classification. Pathology is further divided among *remote* and *local* sources. *Remote* sources of pathology occur distant from where symptoms are perceived (eg, neurofibroma of the common peroneal nerve causing lower leg and foot pain) and include referred pain (eg, axillary pain from myocardial ischemia). By contrast, *local* sources of pathology occur in the immediate vicinity of a patient's chief concern (eg, calf muscle rupture causing lower leg pain). Remote sources of pathology should be considered before local sources, because they more commonly may be overlooked.

The potential diagnoses are then sorted by likelihood from epidemiology and specific features already known about the case (eg, pathology common to women versus men). Unlikely causes are then removed from the diagnostic hypothesis list. The physical therapist then asks focused questions to rule less likely a specific condition or pathologic category in order to further elucidate the nature of the problem. Using the patient's responses, the physical therapist then re-sorts the diagnostic hypothesis list by eliminating less likely causes. Subsequently, tests are performed in the order of their importance to differentiate among the remaining candidates on the diagnostic hypothesis list. Finally, the physical therapist makes a diagnostic impression based on the information gathered, which guides the decision whether referral to another health care provider, initiation of intervention, or a combination of both is optimal to address the patient's chief concern.

This case series will demonstrate the use of this hypothesis-oriented algorithm for symptom-based diagnosis in physical therapist practice. Information from history and physical examination findings for 2 individuals referred to an outpatient physical therapy clinic with LBP will be used to illustrate its use. Case management and treatment considerations specific to each patient will be discussed.

PATIENT ONE

Case Description

Patient One was a 69-year-old retired female who was referred to physical therapy by a family practice physician with a referral diagnosis of "chronic LBP for 10 years." She also presented with a productive cough and conjunctivitis of the right eye, although she identified her LBP as her chief concern. She described episodic LBP since injuring

herself lifting a box at work. Her previous symptoms usually began slowly and resolved within a few days without treatment. The current episode began insidiously 2 months prior to physical therapy evaluation. Patient One described her symptoms as "constant, dull, and aching" pain across the lower back with occasional radiation to the anterior and posterior left thigh. She rated her minimum pain a 7/10 and maximum pain 8/10 on a 10-point verbal analogue scale (VAS), with 10 representing the worst imaginable pain. Her symptoms worsened with walking greater than 30 minutes. Her pain was described as worse in early morning and at the end of the day. She denied any alleviating factors. Recent magnetic resonance imaging of the lumbar spine demonstrated moderate central stenosis at L4-L5 due to spondylolisthesis, degenerative changes at L2-4 and L5-S1, and several cystic structures in the left posterolateral L4-5 lamina consistent with synovial cysts. Her medical history included non-Hodgkin's lymphoma diagnosed 12 years prior to initial evaluation, successfully treated with chemotherapy and radiation; thyroid cancer diagnosed 8 years prior to initial evaluation; and squamous cell carcinoma of the larynx diagnosed 2 months prior to initial evaluation treated with a total laryngectomy. Her medications included levothyroxine (1 mcg/kg/day) and celebrex (200mg/day). Patient one showed limited knowledge regarding the nature of her previous cancer treatments, as well as the identity and specialties of her attending physicians. She presented with significantly impaired speech due to her recent laryngectomy. Her body weight was 70.3 kg and she measured 160 cm tall (body mass index [BMI] 27.5 kg/m^2).

Process of Symptom-based Diagnosis

Identify the patient's chief concern

Patient One reported her chief concern as back pain.

Determine Yellow Flags

Several Yellow Flags became apparent during the initial physical therapy evaluation for Patient One. Her recent laryngectomy made communication difficult and could have led to vital information being missed without special efforts. Her prior history of 'mechanical' LBP also could have led to neglecting further investigation of other causes of LBP that are not amenable to physical therapy intervention. Additionally, Patient One was new to her referring physician and her previous history of cancer may have been overlooked as a cause of lower back pain. She also was referred to physical therapy with a symptom-based diagnosis of "chronic LBP for 10 years." During the initial portion of the evaluation, Patient One revealed her current complaint of back pain was 'new' in the last 2 months and 'different' from previous episodes. She considered this incident different in both quality and intensity compared to her previous episodes of LBP. This information was a Yellow Flag because it seemed inconsistent with the referral diagnosis.

Determine Red Flags

Red Flags that were identified from the overall clinical presentation included the patient's age greater than 50 years coupled with a recent history of cancer. This information itself did not require immediate referral to a physician, but raised the index of suspicion regarding a potential recurrent neoplastic condition with possible spinal metastasis. The traditional Red Flag of unremitting pain was considered less strongly due to its lack of specificity.[7]

Create a symptom timeline

Patient One had non-Hodgkin's lymphoma 12 years prior to physical therapy evaluation followed by thyroid cancer 4 years later (Figure 1A). She underwent a recent total laryngectomy due to recurrence of her cancer 2 months prior to physical therapy evaluation, and at approximately the same time noted the onset of her LBP.

Create a diagnostic hypothesis list considering all the possible forms of remote and local pathology that could cause the patient's chief concern

Possible causes of this patient's symptoms were considered. These conditions included metastatic cancer, infection, rheumatologic disease, and neurologic disorders (Table 2). The possibility of referred pain from other visceral systems was also considered such as pelvic inflammatory disease, renal or urinary disease, and gastrointestinal disorders (eg, diverticulitis, duodenal ulcer). Local forms of pathology considered included spinal stenosis, facet arthropathy/degeneration, spondylolisthesis, myofascial pain, and Reiter syndrome (Table 2).

Sort the diagnostic hypothesis list by epidemiology and specific case characteristics

The diagnostic hypothesis list was resorted based on epidemiological factors of age and sex (Table 2A). Possible remote causes of Patient One's symptoms included

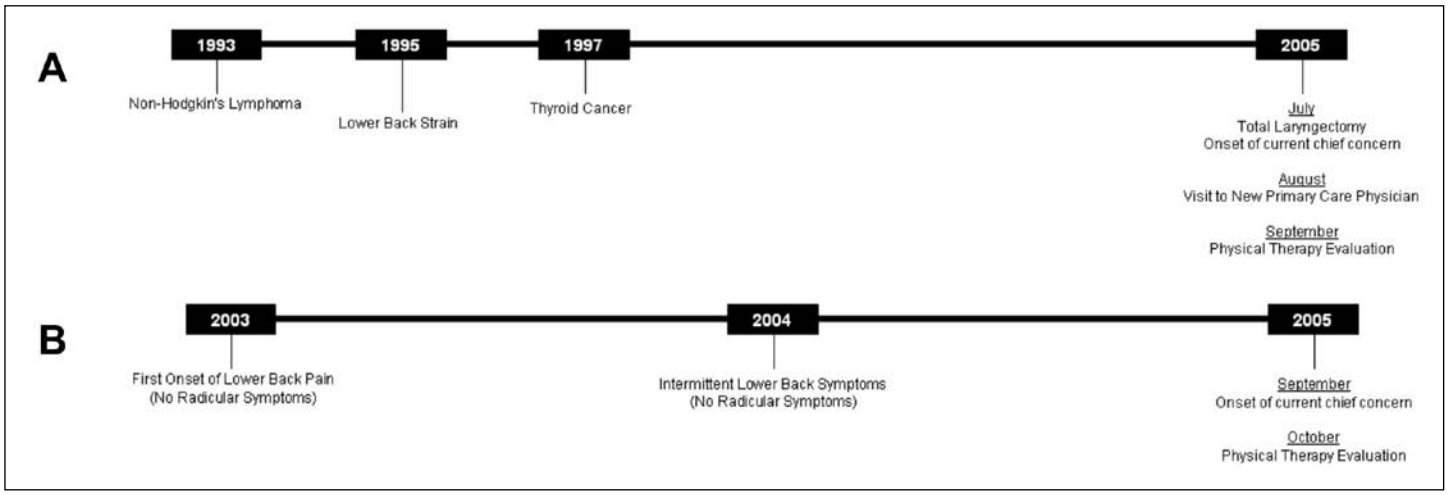

Figure 1. Timeline of symptoms for Patient One (A) And Patient Two (B).

Table 2. Conditions That May Lead to Lower Back Pain*

	Trauma	Inflammation	Metabolic	Vascular	Degenerative	Tumor	Congenital	Neurogenic/ Psychogenic
Remote	Not applicable	*Aseptic* Crohn's disease *Septic* Appendicitis Arachnoiditis/ meningitis Bacterial endocarditis Cholecystitis Diverticulitis Duodenal ulcer Epidural abscess Herpes zoster Pancreatitis Pelvic inflammatory disease Pleuritis Prostatitis Renal or urinary tract infection Splenic abscess	Ectopic pregnancy Endometriosis	Aortic or iliac aneurysm Aortic or iliac arteriosclerosis Arteriovenous malformation of the spinal cord Epidural hematoma Infarction: • Kidney • Spinal cord/ conus medullaris • Spleen	Not applicable	*Malignant Primary, such as:* Carcinoma of the colon Multiple myeloma Retroperitoneal tumor Spinal cord tumor *Malignant Metastatic, such as:* Metastatic cancer (including from breast, lung, prostate, kidney and thyroid) *Benign, such as:* Ovarian cysts Uterine fibroids	Not applicable	Anxiety Depression Malingering Munchausen's syndrome Secondary gain Somatoform disorder
Local	Acute lumbar sprain/strain Disc disruption (with or without herniation) Facet syndrome Myofascial pain disorder Traumatic fracture • Burst • Compression • Pars interarticularis Traumatic spondylolisthesis	*Aseptic* Ankylosing spondylitis Complex regional pain syndrome Fibromyalgia Psoriatic arthritis Polymyalgia rheumatica Reiter's syndrome Rheumatoid arthritis *Septic* Paraspinal muscle abscess Psoas muscle abscess Septic discitis Spinal osteomyelitis Subdural abscess Transverse myelitis Tuberculosis	Insufficiency fracture secondary to osteoporosis Paget's disease	Not applicable	Degenerative spondylolisthesis Disc degeneration Spinal stenosis Spondylolysis	*Malignant Primary, such as:* Primary bone tumor (eg, osteosarcoma, Ewing's sarcoma, fibrosarcoma, and chondrosarcoma) *Malignant Metastatic, such as:* Metastatic cancer (including from breast, lung, prostate, kidney and thyroid) *Benign, such as:* Intraspinal lipoma	Tethered spinal cord	Not applicable

*Diagnostic lists courtesy of Michael A. Andersen, DPT, OCS and J. Raul Lona, DPT in preparation as a textbook contribution.

metastatic disease, aseptic inflammation, and septic inflammation of the abdominal and pelvic organs. Local forms of pathology were considered, including traumatic (eg, lumbar disc disease, myofascial pain), degenerative (eg, facet arthropathy/degeneration, spondylolisthesis, spinal stenosis), aseptic inflammation (eg, Reiter syndrome), and septic conditions (eg, discitis, spinal osteomyelitis) primary malignant tumors (eg, osteosarcoma), malignant metastatic tumors (eg, from primary thyroid cancer), and benign tumors (eg, intraspinal lipoma).

Ask specific questions to rule specific conditions or pathologic categories less likely

Patient One was asked questions that addressed the possibility of remote conditions first. She denied involvement of multiple other joints (decreased likelihood of aseptic conditions); concomitant abdominal or pelvic pain (decreased likelihood of conditions involving these organs); change in bowel or bladder frequency, color, or consistency (decreased likelihood of gastrointestinal or renal/pelvic referral); and recent history of malaise, fever, chills, or nausea (somewhat decreased likelihood of septic disease). Patient One acknowledged losing 14 kg over a period of 2 months, and she attributed this to her recent laryngectomy. In addition, she acknowledged night sweats that occurred 2 to 3 times per week over the prior 2 months.

Re-sort diagnostic hypothesis list based on the patient's responses to specific questioning

After obtaining the answers from the focused questions, pathology outside the scope of physical therapist practice could not be ruled less likely (Table 2B). Patient One's re-

Table 2A. Diagnostic Hypothesis List for Patient One Revised According to Pertinent Epidemiology and Information from the Patient Interview

	Trauma	Inflammation	Metabolic	Vascular	Degenerative	Tumor	Congenital	Neurogenic/ Psychogenic
Remote		*Aseptic* Crohn's disease *Septic* Pelvic inflammatory disease Renal or urinary tract infection		Aortic or iliac arteriosclerosis		*Malignant Primary, such as:* Carcinoma of the colon Multiple myeloma Retroperitoneal tumor Spinal cord tumor *Malignant Metastatic, such as:* Metastatic cancer (from thyroid) *Benign, such as:* Ovarian cysts Uterine fibroids		Anxiety Depression Malingering Somatoform disorder
Local	Acute lumbar sprain/strain Disc disruption (with or without herniation) Facet syndrome Myofascial pain disorder	*Septic* Septic discitis Spinal osteomyelitis	Insufficiency fracture secondary to osteoporosis		Degenerative spondylolisthesis Disc degeneration Spinal stenosis Spondylolysis	*Malignant Primary, such as:* Primary bone tumor (eg, osteosarcoma) *Malignant Metastatic, such as:* Metastatic cancer (from thyroid) *Benign, such as:* Intraspinal lipoma		

cent 14 kg weight loss in the 2 months prior to physical therapy evaluation accounted for nearly 20% of her total body weight. This is remarkable because an unintended weight change greater than 10% in one month may raise concern for neoplastic disease.[8] In addition, she reported night sweats that occurred 2 to 3 times per week over the same time period, which may suggest neoplastic disorder or septic inflammation. Some of the local traumatic and degenerative pathologies were confirmed by previous MRI findings, so they remained on the diagnostic hypothesis list.

Perform tests to differentiate between the remaining diagnostic hypotheses

Patient One's oral temperature was 36.7°C. Peripheral neurologic evaluation revealed diminished bilateral patellar and Achilles reflexes, vibratory testing revealed intact sensation to bilateral lower extremities with the exception of impairment noted at the medial leg bilaterally. Manual muscle testing[9] revealed hip flexors 3+/5 bilaterally; quadriceps 4/5 right, 4-/5 left; extensor hallucis longus 5/5 bilaterally; peroneals 5/5 bilaterally and tibialis anterior 5/5 bilaterally. Sustained active lumbar extension reproduced local lower back pain. The diagnostic hypothesis list was reorganized based on these focused physical examination findings (Table 2c).

Decide on a diagnostic impression and determine the appropriate patient disposition

Although several traumatic and degenerative conditions remained possible causes due to Patient One's reproduction of symptoms with active lumbar extension and apparent neurologic deficits, the inability to rule tumor less likely as a cause of Patient One's symptoms prompted a referral to her oncologist. Patient One's previous history of cancer, age greater than 50 years, night sweats, and recent unintended 20% weight loss contributed to the physical therapist's diagnostic impression of possible neoplastic disease.[8,10] Infection appeared less likely due to no recent history of fever, chills, malaise, or other symptoms typically related with infection. Her oncologist was selected rather than the referring internist due to his familiarity with the Patient One's case. Upon referral, blood tests and imaging were requested to help rule primary and metastatic cancer less likely as a cause of her symptoms. These additional tests revealed elevated thyroglobulin levels characteristic of a recurrence of thyroid cancer, which was confirmed as spinal metastasis with computed tomography.

PATIENT TWO

Case Description

Patient Two was a 24-year-old male student referred to physical therapy by a family practice physician with a referral diagnosis of "low back pain." He reported an insidious onset of intermittent ache in the lower back with sharp radiating pain down the right posterior leg 1 month prior to physical therapy evaluation. Patient Two rated his LBP at 5/10 on VAS, and the occasional sharp shooting pain was rated 8-9/10. He reported his disablement had remained relatively stable since its initial onset. Aggravating factors included prolonged sitting, bending, lifting, and driving greater than 10 minutes, and his pain was worst early in the morning. Alleviating factors involved laying supine with lower extremities elevated on a pillow. Patient Two's past medical history was significant for previous episodes of low back pain over a period of 2 years, which resolved without need for physical therapy intervention. These prior episodes were localized to the lower back. Otherwise, Patient Two considered himself to be 'healthy.' He took naprosyn (500 mg/BID) for approximately 22 days prior to physical therapy evaluation and reported no benefit. His body weight was 70.3 kg and he measured 178 cm tall (BMI 22.2 kg/m^2).

Process of Symptom-based Diagnosis

Identify the patient's chief concern

Patient Two reported his chief concern as lower back pain.

Determine Yellow Flags

Yellow Flags included Patient Two's relatively young age and seeming good health, because these perceptions could lead a physical therapist away from investigating sources of pathology aside from trauma in determining the appropriateness of physical therapy to address his disablement.

Determine Red Flags

Patient Two's aggravation of symptoms with sitting and bending were considered indicative of lumbar disc pathology, particularly considering his radiating pain.

Create a symptom timeline

Patient Two reported a prior history of LBP 2 years ago which resolved without intervention. The onset of his current episode of LBP was 1 month prior to the physical therapy evaluation (Figure 1B).

Table 2B. Diagnostic Hypothesis List Revised for Patient One According to Physical Examination Findings

	Trauma	Inflammation	Metabolic	Vascular	Degenerative	Tumor	Congenital	Neurogenic/ Psychogenic
Remote						*Malignant Primary, such as:* Carcinoma of the colon, Multiple myeloma, Retroperitoneal tumor, Spinal cord tumor *Malignant Metastatic, such as:* Metastatic cancer (from thyroid)		
Local	Facet syndrome Myofascial pain disorder		Insufficiency fracture secondary to osteoporosis		Degenerative spondylolisthesis Disc degeneration Spinal stenosis Spondylolysis	*Malignant Primary, such as:* Primary bone tumor (eg. osteosarcoma) *Malignant Metastatic, such as:* Metastatic cancer (from thyroid)		

Create a diagnostic hypothesis list considering all the possible forms of remote and local pathology that could cause the patient's chief concern

Possible remote causes of Patient Two's symptoms were considered next; these conditions included metastasis from testicular cancer, infection (meningitis), and renal/urinary disease (Table 2). Local forms of pathology were considered next; these conditions included disc disruption (with or without herniation), lumbar sprain/strain, and facet syndrome.

Sort the diagnostic hypothesis list by epidemiology and specific case characteristics

The list was resorted based on epidemiological factors (Table 3A). The possible remote causes of Patient Two's symptoms included referred pain from septic inflammation (eg, diverticulitis, duodenal ulcer, pelvic inflammatory disease), renal or urinary disease, primary malignant tumor (eg, osteosarcoma), and malignant metastatic tumor (eg, testicular cancer). Local forms of pathology included lumbar strain/sprain, disc disruption (with or without disc herniation), facet syndrome, myofascial pain, ankylosing spondylitis, Reiter syndrome, septic inflammatory disorders (eg, tuberculosis, discitis, spinal osteomyelitis), spondylosis, and tumors.

Ask specific questions to rule specific conditions or pathologic categories less likely

Patient Two first was asked a series of questions that considered the possibility of remote pathology. He denied recent history of coughing, malaise, fever, chills, or nausea (decreased likelihood of septic conditions); testicular or groin pain (decrease likelihood of testicular cancer/referral, pelvic inflammatory disease, and Reiter syndrome); involvement of multiple joints (decreased likelihood of aseptic inflammation, except perhaps ankylosing spondylitis); abdominal or pelvic pain, as well as change in bowel or bladder frequency, color, or consistency (decreased likelihood of gastrointestinal, renal, or pelvic organ referral). Patient Two then was asked a series of questions that considered the possibility of local lumbar spine pathology. He acknowledged experiencing an increase in LBP during coughing or sneezing, and confirmed his peripheralization of pain to the right lower extremity with flexed positions, such as sitting and bending forward.

Re-sort diagnostic hypothesis list based on the patient's responses to specific questioning

After obtaining the answers from the focused questions, it appeared that he did not present with signs associated with cancer or infection. Indeed, he denied any change in his health other than his current complaint of LBP. Following questioning, Patient Two's symptoms appeared most consistent with local causes of pain, such as lumbar disc disruption with radiculopathy (Table 3B).

Perform tests to differentiate between the remaining diagnostic hypotheses

Vital signs were not taken at the time of initial evaluation because the diagnostically focused questions helped to decrease the likelihood of pyrogenic conditions. Selected tests focused mostly on the local forms of pathology considered. Neurological evaluation revealed normal bilateral Achilles and patellar reflexes, and vibration testing revealed intact sensation to bilateral lower extremities. Myotomal manual muscle testing[9] was normal. Ipsilateral straight leg raise peripheralized symptoms at occurred at 30° of hip flexion and contralateral straight leg raise reproduced these symptoms at 38°of hip flexion. Lumbar AROM revealed decreased lumbar flexion with a deviation to the left (with reproduction of symptoms), extension and side-bending range of motion appeared grossly within normal limits (with increased pain and peripheralization of symptoms during right sidebending).

Decide on a diagnostic impression and determine the appropriate patient disposition

History and physical examination findings suggested it was unlikely that Patient

Table 3A. Diagnostic Hypothesis List for Patient Two Revised According to Pertinent Epidemiology and Information from the Patient Interview

	Trauma	Inflammation	Metabolic	Vascular	Degenerative	Tumor	Congenital	Neurogenic/ Psychogenic
Remote		*Aseptic* Crohn's disease *Septic* Renal or urinary tract infection				*Malignant Primary, such as:* Multiple myeloma Retroperitoneal tumor Spinal cord tumor *Malignant Metastatic, such as:* Metastatic cancer (including from breast, lung, prostate, kidney and thyroid)		Anxiety Depression Malingering Somatoform disorder
Local	Acute lumbar sprain/strain Disc disruption (with or without herniation) Facet syndrome Myofascial pain disorder	*Aseptic* Ankylosing spondylitis Reiter's syndrome *Septic* Paraspinal muscle abscess Psoas muscle abscess Septic discitis Spinal osteomyelitis				*Malignant Primary, such as:* Primary bone tumor (eg, osteosarcoma) *Malignant Metastatic, such as:* Metastatic cancer (including from breast, lung, prostate, kidney and thyroid) *Benign, such as:* Intraspinal lipoma		

Table 3B. Diagnostic Hypothesis List Revised for Patient Two According to Physical Examination Findings

		Trauma	Inflammation	Metabolic	Vascular	Degenerative	Tumor	Congenital	Neurogenic/ Psychogenic
Remote									
Local	Acute lumbar sprain/strain Disc disruption (with or without herniation) Facet syndrome Myofascial pain disorder								

Two presented with pathology that necessitated referral back to a physician for additional tests or treatment. Several findings implicated lumbar disc disruption. Disc herniations usually occur between the ages of 30 and 55 years.[11] Patient Two reported radiating pain down the posterior right lower extremity with occasional parasthesias, which was consistent with the L5 dermatome. His pain also was aggravated by sitting and flexed positions of the lumbar spine, which increase compressive forces and the intradiscal pressure.[12] His pain was alleviated with standing and extended postures. He reported increased pain during coughing/sneezing which also increases the intrathecal pressure and his pain was worse in the morning which is when the disc volume is at its greatest. Finally, ipsilateral and contralateral straight leg raise tests reproduced his characteristic symptoms. More importantly, however, other factors helped to rule other causes to be less likely, including the patient's denial of any recent weight loss, illness, fever, malaise, and other joint pain. Patient Two was treated for 6 weeks with McKenzie repeated extension exercises to centralize symptoms, manual traction, and lumbar stabilization exercises. He subsequently returned to his prior level of function without symptoms.

DISCUSSION

Increasing roles for physical therapists in primary care settings place a premium on efficient and thorough processes to determine the appropriateness of physical therapy for patients and direct treatment. The approach to symptom-based diagnosis for physical therapists described in this case series is characterized by a structured method of clinical hypothesis testing in an attempt to optimize accuracy. This approach aimed to optimize efficiency through diagnostically focused questions and tests that were customized to each patient's presentation, and used the knowledge of clinical presentation and underlying pathophysiology of specific medical conditions.

In this case series, the physical therapist's decisions regarding appropriate patient disposition were based on diagnostic impressions, involving a short list of most likely conditions culled from a list of all possibilities through the information gathered by history and physical examination. Clearly, the purpose of this hypothesis-based algorithmic process is not intended to determine authoritatively the exact cause of the patient's chief concern (ie, "THE Diagnosis"), but rather to suggest the most likely forms of pathology in order to decide the appropriateness for physical therapy for patients and direct treatment accordingly. The use of a hypothesis-oriented algorithm for symptom-based diagnosis by physical therapists does not appear to preclude the use of the various patient-oriented classification to direct treatment, including movement assessment, treatment-based classification, and application of clinical prediction rules. Rather, symptom-based diagnosis by physical therapists will facilitate optimal outcomes by strengthening initial selection for these patient-oriented classification schemes.

Physical therapy was determined to be inappropriate for Patient One at the time of the evaluation. This decision was made based on the information provided by Red Flags and questions asked in an attempt to rule tumor less likely as a cause of the patient's chief concern. The questions that were chosen are historically associated with medical screening, however, the focused questions and the accompanying physical examination techniques intended to test hypotheses highlighted the clinical reasoning involved in this case series as a diagnostic process rather than true medical screening. Patient Two's physical examination findings suggested that it was unlikely he presented with pathology necessitating immediate referral to a physician. Interestingly, the physical therapist's relative confidence in the pathoanatomic diagnostic impression derived from history and physical examination findings guided the intervention. However, a definitive pathoanatomic diagnostic label is difficult to achieve in many patients with lower back pain.[13]

Physical therapists at all levels of experience appear capable of learning and using processes of symptom-based diagnosis because of their educational preparation in physiology, pathology, and movement dysfunction mandated by the Committee on Accreditation of Physical Therapist Education[14] and described in the *Guide to Physical Therapist Practice*.[15] Initial experience teaching this process to student physical therapists in entry-level, postprofessional, and residency programs has been promising. However, additional work appears necessary to determine the effectiveness and refine the efficiency of this process.

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Isolated Posterior Cruciate Ligament Injuries Part I: Anatomy, Biomechanics, Mechanism of Injury, and Examination

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ABSTRACT

Injuries to the posterior cruciate ligament (PCL) are less frequent when compared to the anterior cruciate ligament. As a result, the orthopaedic/sports physical therapist may be less familiar with the intricacies of injuries to the PCL. The natural history of the isolated PCL injury remains unclear and unpredictable. While some cases are benign, other cases are associated with progressive deterioration and disability. Since the outcomes from current surgical techniques are not superior to conservative rehabilitation, nonoperative care remains the mainstay of treatment. It is therefore imperative an effective examination, evaluation, and intervention program based on applied anatomy and biomechanics be implemented. This is the first paper of a 2-part series. Part 1 reviews the anatomy, biomechanics, mechanism of injury, physical examination, and differential diagnosis of the PCL and PCL injuries. Part 2 will review the natural history and rehabilitation principles for individuals with PCL injuries. In addition, a case study applying the principles discussed in this series will also accompany Part 2.

Key Words: injuries, isolated, knee, posterior cruciate ligament, review

INTRODUCTION

Over the last decade the anterior cruciate ligament (ACL) has received considerable attention while literature on the posterior cruciate ligament (PCL) has lagged behind. This is most likely related to the lower frequency at which these injuries occur.[1] In fact, the incidence of isolated PCL injury has been reported to make up as few as 3% to 4% of all knee ligament injuries.[2,3] Therefore, clinicians may not be as familiar with examination, evaluation, and intervention related to these injuries. This unfamiliarity may inadvertently lead to misdiagnosis or mismanagement during the rehabilitation process and compromise patient care. The purpose of this paper is to review the anatomy, biomechanics, mechanism of injury, physical examination, and differential diagnosis with respect to the PCL.

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ANATOMY

The posterior cruciate ligament originates in a semi-circular fashion from the lateral aspect of the medial femoral condyle.[4,5] Its origin is quite broad and measures on average 32 mm in the anterior-posterior direction.[4] The ligament courses in an inferior oblique (medial to lateral) manner to insert 10 mm below the level of the tibial plateau centrally.[4,6] The PCL has been described as having 2 bands: the larger anterolateral and the smaller posteromedial band.[7,8] The PCL averages 38 mm in length (similar to the ACL) and 13 mm in width (two mm larger than the ACL).[5] Overall, the ligament is widest at its femoral origin and narrowest near the tibial insertion.[8] The PCL is covered by a synovial lining and is therefore considered to be extra-synovial yet intra-articular.[5,8] In concert with the PCL are the anterior and posterior meniscofemoral ligaments. Although these ligaments arise from the common PCL origin they are distinct structures having different insertion sites.[7,9] The anterior and posterior meniscofemoral ligaments are named with respect to their orientation to the PCL. The anterior meniscofemoral ligament (AMFL), also known as the 'ligament of Humphrey,' runs anterior to the PCL and inserts on the posterior aspect of the lateral meniscus.[7] The posterior meniscofemoral ligament (PMFL), also known as the 'ligament of Wrisberg,' runs posterior to the PCL to insert either on the superior/lateral aspect of the tibia, the posterior aspect of the lateral meniscus, or the posterior capsule.[6] The anterior and posterior meniscofemoral ligaments have been reported on average to be approximately 22% of the cross-sectional area of the PCL.[8] Conversely, some work has reported the PMFL to be as large as one half of the diameter of the PCL.[10] The incidence of the anterior and posterior meniscofemoral ligaments are variable. However, when data from cadaver studies were collectively examined, either the AMFL or PMFL was present 91% of the time.[11] In 48% of the cases, the AMFL was present while 70% of the specimens exhibited a PMFL.[11]

The PCL receives nerve supply from branches of the tibial nerve. Small branches of the tibial nerve have been described to course along the synovial lining of the PCL.[12,13] The function of this nerve supply is questionable although it may serve as proprioceptive in nature.[12,14] The blood supply to the PCL is largely provided from the middle and inferior geniculate branches of the popliteal artery.[12]

BIOMECHANICS

The PCL is located very near the long axis of tibial rotation and has been described as the main stabilizer of the knee.[15] It is more vertical in extension and horizontal in flexion.[4] With flexion and extension of the knee, a complex serial/progressive tightening and loosening of the ligament takes place as it winds and unwinds upon itself. Overall, the ligament is most taut with further flexion of the knee.[16] Specifically, the anterolateral band is most taut in flexion while the posteromedial band is most taut in extension.[8] The PCL is the primary restraint to posterior translation of the tibia on the femur[17,18] and has been reported to provide up to 95% of the posterior restraining force.[19] The contribution percentage resisting posterior translation decreases as the knee extends.[17] Other functions of the PCL include acting as a secondary restraint to lateral rotation of the tibia on the femur at 90° of flexion,[17] assisting with the rolling/gliding mechanism of the tibiofemoral joint, and resisting varus/valgus forces at the knee after the collateral ligaments have failed. As

the meniscofemoral ligaments are similar in orientation to the PCL, their behavior is likewise similar to the PCL. They act as secondary stabilizers to posterior translation of the tibia on the femur but also assist with mobilizing the lateral meniscus.[4,11] The insertion sites of the meniscofemoral ligaments are different than that of the PCL. Therefore, if a mid-substance tear of the PCL occurs, it is possible that one or both of the meniscofemoral ligaments may remain intact.[20]

The tensile strength of the PCL has been reported to be 2 times that of the ACL.[21] More recent study has quantified not only the ultimate tensile strength but also the linear stiffness of the individual anterolateral and posteromedial bands of the PCL as well as that of the meniscofemoral ligaments.[8,22] These data indicate the anterolateral band (1120 ± 362 N) is able to withstand greater loads than the posteromedial band (419 ± 128 N) and both anterior (310 ± 155N) and posterior (302 ± 157N) meniscofemoral ligaments.[8,22] Likewise, linear stiffness of the anterolateral band was greater than the posteromedial band and meniscofemoral ligaments.[8]

MECHANISM OF INJURY

The PCL is predominately injured by one of two mechanisms. The first is by what has been described as a 'dashboard injury.'[9] This involves a posteriorly directed force on the anterior, superior aspect of the tibia.[23] This frequently occurs during a motor vehicle accident in which the passenger's knee violently strikes the dashboard driving the tibia posterior thereby rupturing the PCL.[24] In athletics, this mechanism may result from a blow to the anterior tibia during activities such as tackling or blocking[25] or by a fall on a flexed knee with the foot in plantarflexion.[9,24] A fall with the foot in plantarflexion enables the tibia to be driven posterior on the femur whereas with the foot in dorsiflexion, the patellofemoral joint is more commonly injured.[9]

A second mechanism by which the PCL is torn involves hyperflexion of the knee.[26] This mechanism has been reported to be common during sport activities.[26] The PCL may also be injured as a result of hyperextension of the knee[23,25] but only after the anterior cruciate ligament has been torn.[9] There is disagreement in the literature as to which mechanism is more frequent. Several authors have reported the 'dashboard' mechanism is more common[24,27] while others have reported that hyperflexion of the knee is more frequent.[26]

PHYSICAL EXAMINATION

In the normal state with the knee flexed to 90°, the tibial plateaus sit approximately 1 cm anterior to the femoral condyles. Clinically, this orientation is commonly referred to as the anterior 'step off.' While the hallmark of a PCL tear is a decrease in the anterior 'step off' from the femoral condyles to the tibial plateau, the signs and symptoms of acute and chronic PCL injuries present in slightly different manners, and therefore warrant individual discussion.

Signs & Symptoms - Acute

Signs of an acute isolated PCL tear may be subtle and are frequently missed upon initial presentation.[27, 28] Compounding matters, many patients do not report the injury acutely or at all.[6] Therefore, it is likely the overall incidence of PCL injury is underestimated. Subjectively, unlike patients who tear their ACL, following an isolated PCL tear, patients rarely report hearing or feeling a 'pop.'[29] Additional clinical features of the acutely isolated PCL injured knee include:

Minimal swelling

Dissimilar compared to an acute ACL injury only minimal swelling may be present following PCL injury.[20,26] It has been suggested that with injury to the PCL, a small hole in the capsule may be present thereby allowing fluid to drain into the calf.[25]

Anterior abrasion

An abrasion or contusion on the superior, anterior aspect of the tibia suggests the occurrence of a posteriorly directed force of the tibia on the femur.[30, 31] Abrasions to this location appear to be more common following a MVA compared to injury sustained during sporting activity.

Range of motion

Minimal pain is typically present with extension while pain is present past 90° and the patient may lack 10° to 20° of flexion.[9,32]

Ligamentous testing

A decrease in the anterior 'step off' from the femoral condyles to the tibial plateau is variable in the acute setting.[33] The presence of an effusion or quadriceps muscle guarding may mask this sign.[34]

Signs & Symptoms - Chronic

Common clinical features of an isolated PCL injured knee include:

Pain

Patients with symptomatic, chronic PCL tears have been described as suffering from 'disability' secondary to pain.[20] With the tibia subluxed posteriorly, the pressure on the articular surfaces of the patellofemoral joint and medial tibiofemoral compartment is increased predisposing it to premature degenerative changes.[35]

Sag

A positive posterior drawer test is more frequent.[20, 25] The effects of gravity over time encourage further 'stretching' or microscopic failure of the secondary restraints allowing greater subluxation.

Range of motion

Range of motion is typically full.[36]

Giving way

Patients with chronic insufficiency of the PCL have been noted to complain of 'giving way.'[20] Episodes of instability have been reported during activities such as descending stairs or ambulating on uneven surfaces.[20] With chronic isolated injuries, instability is often attributed to pain rather than a true mechanical deficiency as would occur during a pivot shift.[6]

Limb alignment

As the injury becomes more chronic and secondary restraints (particularly those in the posterolateral corner) become more lax, mechanical instability however may develop. In particular, the tibia is prone to subluxing into a posterior and externally rotated position. This is further accentuated by increases in extension as well as the development of medial compartment arthritis.[37] The lower extremity may appear 'bowed' or display a varus angulation.[37] Given the normal adduction moment that occurs in early stance, alignment of this nature will augment the adduction moment and may contribute to instability and the presence of a varus thrust during simple ambulation.[6, 37]

Special Tests

Given the primary function of the PCL, it is logical that physical examination of the knee for suspected PCL insufficiency emphasizes detection of altered posterior position and sagittal translation of the tibia on

the femur. To minimize the likelihood of a false-negative or false-positive finding, the anterior-posterior exam should be initiated at 90° of flexion in neutral rotation. In a nonpathologic knee, the tibial plateau rests 10mm anterior to the femoral condyles.[9] In a knee with injury to the PCL, the tibia may need to be reduced before quantifying posterior translation. As with any joint, there are a myriad of tests which have been reported in the literature. Commonly used tests include the posterior drawer test, posterior sag test, and quadriceps active test. As with all tests, the results should be compared to the normal, contralateral lower extremity.

Posterior Drawer

The patient lies supine with the hip flexed to 45°, knee to 90°, and the foot flat on the table. The examiner stabilizes the affected lower extremity by partially sitting on the ipsilateral foot. The examiner then, if necessary, restores the normal sagittal plane relationship between the femoral condyles and tibial plateaus. Next, with the patient's quadriceps relaxed, the examiner applies a posteriorly directed force to the proximal tibia with both hands (Figure 1). The amount of posterior excursion and quality of the 'end feel' are assessed. Injuries to the PCL are graded as I, II, and III. These grades correspond to the amount of posterior translation of the tibia on the femur with a I = 0 - 5mm, a II = 6 - 10mm, and a III >10mm.[28] The medial tibial plateau will remain anterior to the medial femoral condyle with a grade I injury, flush with a grade II injury, and posterior with a grade III injury. A grade I is interpreted as a partial PCL tear, a grade II as a complete tear, and a grade III as a complete tear with possible involvement of the secondary restraints.[28] Overall, the sensitivity and specificity of the posterior drawer test have been reported as 90% and 99% respectively.[38] The results however are dependent upon the grade of injury. Sensitivity and specificity are lower for partial (I) tears (70%; 99%) when compared to complete (II or III) tears (97%; 100%).[38]

Posterior translation of the tibia may also be assessed with the knee in lesser degrees of flexion. Iwata and colleagues demonstrated that patients with isolated PCL deficiency and complaints of 'giving way' during ADLs exhibited greater amounts of posterior translation at both 20° and 45° of flexion when compared to another group of isolated PCL deficient patients without complaints of 'giving way.'[39] As the PCL becomes less taut and posterior capsule more taut as the knee approaches extension, increased translation at these angles suggests these patients may have suffered a combined (PCL plus other capsuloligamentous structures) and not isolated ligamentous injury. Supporting this, Clancy noted patients with combined injuries, compared to those with isolated PCL injuries, more frequently complained of instability when descending stairs and walking on uneven ground.[20]

Posterior Sag Test

The posterior sag test, also known as the Godfrey test, is similar to the posterior drawer only the effect of gravity is enhanced with respect to posterior translation of the tibia on the femur. The patient is positioned supine with both the hip and knee flexed to 90° and observation of the tibial plateau in the sagittal plane in relation to the femoral condyles is noted (Figure 2). Sensitivity and specificity for this test have been reported as 79% and 100% respectively.[38]

Quadriceps Active Test

To perform this test, the patient is positioned supine with the hip flexed to 45°, knee to 90°, and foot flat. The patient is asked to perform an isolated isometric contraction of the quadriceps versus the resistance of the examiner. Specifically, the examiner places his or her hand at the distal tibia, just proximal to the patient's ankle to resist knee extension (Figure 3). In an uninjured knee, 2 to 3 millimeters of posterior translation of the tibia on the femur is normal. In the PCL deficient knee as the tibia is already subluxed posteriorly, it will be drawn anteriorly by the isolated quadriceps contraction.[40] The sensitivity of this test has been reported between 54%[38] and 97%.[40] The discrepancy between these extremes may be rooted in methodological differences. Examiners in the Rubinstein et al study were blinded while those in the Daniel et al study were not. Specificity for the quadriceps active test however has been documented as 97%.[38]

DIFFERENTIAL DIAGNOSIS

Given the tensile strength of the PCL, significant force is required to tear this ligament. Therefore, isolated PCL injuries may be less frequent occurrences as compared to combined injuries.[27] In trauma patients, Fanelli reported of knee injuries that involved the PCL, 96.5% were combined injuries.[41, 42] Conversely, over a 7-year period, Clancy reported that of 124 PCL injuries, half were isolated while the remaining 50% were combined.[9] The percentage of cases that are isolated or combined, similar to injury mechanism are likely dependent upon the setting in which the data were gathered.[32] Higher energy mechanisms (ie, MVA) are thought to result in a higher proportion of combined injuries while lower energy mechanisms (ie, sports) are thought to result in a higher proportion of isolated injuries.[29] As it relates to differential diagnosis, delineating between isolated and combined lesions is critical as intervention recommendations between these groups is different.[32] Specifically, isolated injuries are generally treated in a conservative manner[6,26,36] while combined injuries frequently necessitate more aggressive treatment.[28,32] Additionally, given the

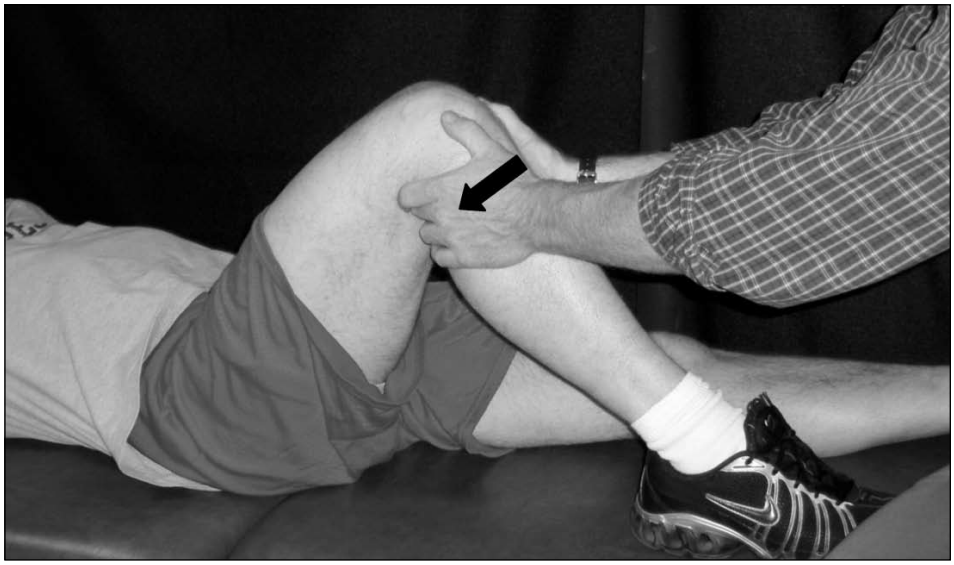

Figure 1. The posterior drawer test.

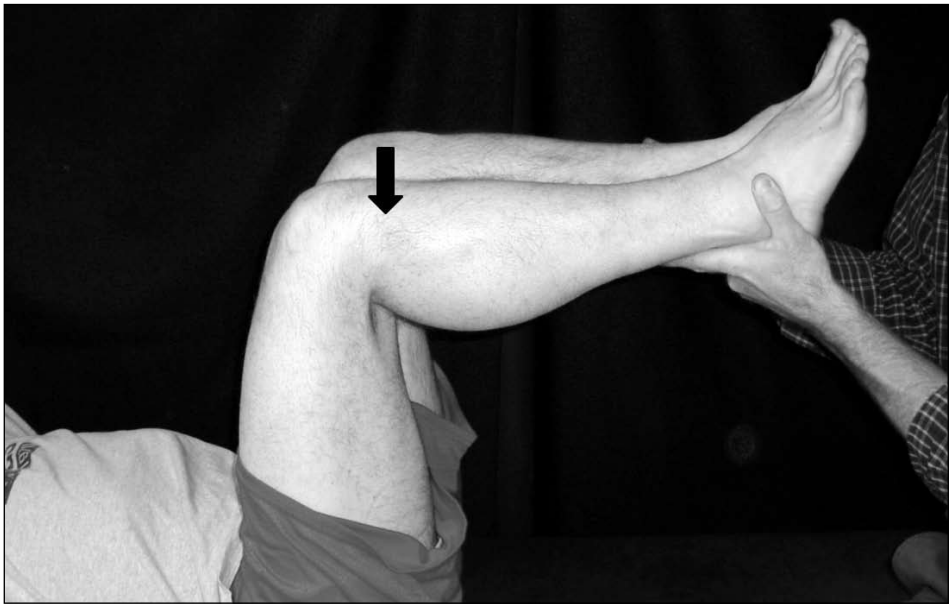

Figure 2. The posterior sag test.

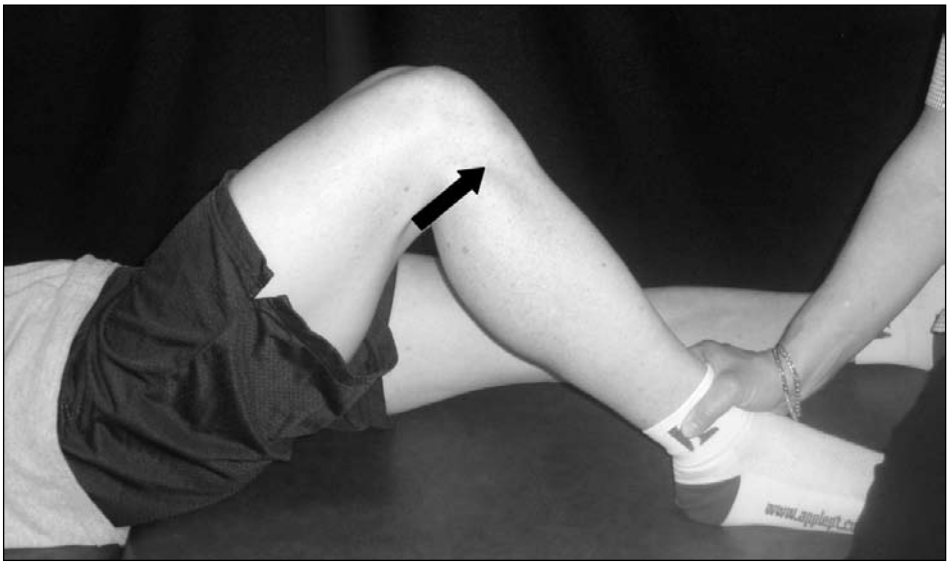

Figure 3. The quadriceps active test.

magnitude of force associated with PCL injury, assessment of local neurovascular structures is essential.

Isolated versus Combined

As previously noted, grade I and II injuries (posterior translation <10mm) are considered 'isolated.' It becomes less clear as to whether an injury is isolated or combined when tibial translation exceeds 10mm. A more detailed examination in these cases beyond those tests that have already been described is therefore necessary. Secondary restraints to posterior translation include the mensicofemoral ligaments and posterior capsuloligamentous structures, namely those in the posterolateral corner but also those in the posteromedial aspect of the knee.

To assess the integrity of the meniscofemoral ligaments and posteromedial capsular structures, the tibia is medially rotated on the femur during the posterior sag test. Less posterior translation has been attributed to tightening of the meniscofemoral ligament(s) and/or greater reliance on the posteromedial capsular tissues.[20,43] No change in translation with medial rotation implies these tissues have been compromised.

Assessment of the posterolateral corner is best performed using the lateral rotation (dial) test.[44] This test may be performed in either the supine or prone position. At 30° of flexion with the femur stabilized in a neutral position, the examiner laterally rotates the tibia on the femur (Figure 4). An increase

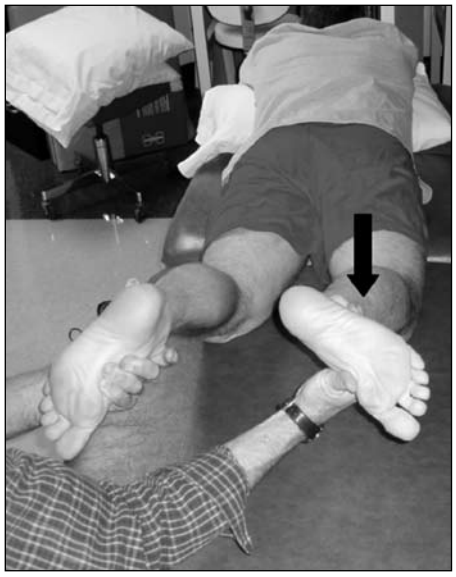

Figure 4. The prone external rotation test.

of at least 10° compared to the contralateral side is considered positive.[45] The examiner should also note the location of the axis of tibial rotation when performing this test. In a normal knee, rotation of the tibia on the femur takes place about a central axis. With injury to the posterolateral corner, the axis shifts closer to the intact tissue or medially.[35] The observed increase in lateral rotation is a result of posterior subluxation of the lateral compartment.

Neurovascular Assessment

Given the mechanisms of injury, the posterior neurovascular structures namely the posterior tibial artery, nerve, and vein are jeopardized and therefore should be evaluated as soon as possible following injury. Also, given the superficial location of the peroneal nerve, it too is at risk for concomitant injury.[27] Palpation of the distal posterior tibialis and dorsalis pedis pulses should be part of the routine exam in these cases. Motor and sensory distributions of the nerves should also be evaluated to rule out gross neurologic involvement. Any abnormal findings should be immediately communicated to the physician so additional testing (ie, arteriogram) as appropriate may be completed.[6, 32]

Imaging

To assist with confirming a diagnosis and/or constructing a plan of care for patients suspected of PCL injury, diagnostic studies including radiographs, magnetic resonance imaging (MRI), instrumented testing, and stress radiographs may be useful. In acute cases, routine radiographs are essential to determine the absence or pres-

ence of associated fracture or an avulsion. Avulsions are more common on the tibial versus femoral aspect of the posterior cruciate ligament.[31] Repair of these lesions has yielded favorable results though appears to be improved if performed acutely.[25,46] In chronic cases, radiographs may be of value with documenting the status of articular degeneration. Intermittent use of bone scans has been suggested as a means to detect early degenerative changes in this population.[35] Magnetic resonance imaging (MRI) has been heralded as the gold standard for assessing PCL injuries.[47] Figure 5 demonstrates a complete rupture of the PCL as visualized with an MRI. Sensitivity and specificity for detection PCL tears with MRI has been reported at 99%.[16,48] Instrumented testing for posterior translation via knee joint arthrometers has yielded conflicting results. Some work has shown arthrometry to be highly sensitive (90%) and specific (100%) for PCL tears[49] while other studies have yielded less favorable results.[50,51] Stress radiography however has shown to be more accurate with diagnosing both partial and complete tears of the PCL when compared to arthrometry or posterior drawer testing.[50]

CONCLUSION

The low incidence and unfamiliarity with PCL injuries may inadvertently lead to misdiagnosis or mismanagement during the rehabilitation process and compromise care given to our patient(s). The anatomy and biomechanics and of the PCL have been well described. Either a direct blow to the tibial tubercle or hyperflexion of the knee are the most common mechanisms of PCL injury. Clinicians need to be aware that the signs and symptoms of acute and chronic PCL injuries present in slightly different manners. Additionally, PCL injuries may involve secondary restraints as well as neurovascular structures. Diagnostic studies including radiographs, magnetic resonance imaging (MRI), instrumented testing, and stress radiographs can be used to assist with confirming a diagnosis and/or constructing a plan of care for patients suspected of PCL injury.

Figure 5. Magnetic resonance imaging that demonstrates a complete posterior cruciate ligament rupture. (Courtesy of Jon K. Sekiya, MD).

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Diagnostic Imaging as an Essential Element in the Physical Therapy Management of a Patient with an Intramuscular Hematoma: A Case Report

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ABSTRACT

Background and Purpose: The purpose of this case report is to describe the presentation, diagnosis, management, and outcome of a patient with an insidious intramuscular hematoma. Particular attention is given to the role of diagnostic imaging as a key element in the differential diagnosis driving the targeted physical therapy treatments and positive outcomes for the patient. **Case Description:** The patient was a 70-year-old female who insidiously developed RUE swelling, pain, LOM, and loss of function and was referred to physical therapy with a medical diagnosis of "right shoulder strain and elbow hematoma." Magnetic resonance imaging identifying a brachialis hematoma, humeroulnar effusion, probable radial head contusion, subcutaneous edema, and possible triceps tendon intrasubstance tears significantly contributed to the identification and staging of the pathologies as well as the development and progression of the physical therapy treatment plan. **Outcomes:** The patient's hematoma significantly reduced in size and pain, ROM, strength, and functional abilities improved over the course of the 5 weeks of physical therapy intervention. **Discussion:** The additional information provided by the patient's diagnostic imaging studies led to a more complete assessment and staging of all of the associated pathologies by the physical therapist. This in turn led to the specific physical therapy interventions and restoration of function for this patient.

Key Words: clinical decision making, magnetic resonance imaging, elbow injury, orthopaedic

INTRODUCTION

Muscle contusions occur often in contact and collision sports or due to traumatic events such as motor vehicle accidents and falls. Less commonly, cases of spontaneous onset of muscle hematomas have been reported.[1,2] Regardless of the apparent causative factors, muscle contusions and hematomas must be differentiated from other soft tissue masses such as fascial tearing with muscle herniation, tumor, or hemangioma.[3] The correct identification of the pathology is necessary to ensure proper management.

Muscle contusions are caused by an external force, like a blow, which creates a compression wave that travels through the soft tissue and drives the deep muscle against the adjacent bone. Typically deep portions of the vastus intermedius quadriceps muscle and brachialis muscle are involved.[4]

Two types of muscular contusion injuries may occur. An intermuscular hematoma involves septal or fascial sheath hemorrhage which usually disperses and causes distal ecchymosis. An intramuscular hematoma does not resolve as quickly and often results in myositis ossificans and scarring.[4]

CASE DESCRIPTION

History

Mrs. K. presented to our outpatient orthopaedic physical therapy clinic, on referral from an orthopaedic surgeon, with a diagnosis of "right shoulder strain and right elbow hematoma." The patient was a 70 y/o female with no recent history of trauma. She reported that 4 weeks prior to onset of signs and symptoms she fell, bracing with the right upper extremity. She denied injury at that time, only mild discomfort in the shoulder. Ten days prior to her presentation in physical therapy, she noted 'tightness' in her right arm which she described as a 'rubber band stretching' and throughout that day she was unable to straighten the elbow. By evening she had significant swelling in the arm. She followed up with her physician the next day and was referred for an orthopaedic consult that included plain film radiographs, which were unremarkable. The physician also ordered a MRI. Later that same evening she developed increasing swelling, redness, and warmth in the RUE. She was evaluated in the local hospital ER, and diagnosed with a probable infection. She was prescribed an antibiotic and the swelling began to subside over several days. A MRI was conducted 4 days after onset of symptoms and was positive for an 'elbow hematoma.' The patient's PMH was remarkable for a right shoulder injury many years ago from which she never achieved full ROM. Her medication profile at the time of the initial physical therapy evaluation included Lopid (an antihyperlipidemic agent), Norvasc (calcium channel blocker), Actonel (biphosphonate for prevention of osteoporosis), OsCal (calcium supplement), folic acid (for treatment of anemia), vitamin D, alpha lipoic acid (an antioxidant), and Cipro (flouraquinolone antibiotic for treatment of the suspected elbow infection).

Physical Therapy Evaluation

The patient's chief complaints were 10/10 pain in the right shoulder and elbow with movement, the inability to straighten her elbow, and a palpable mass in the anterior elbow. Her goals were to control pain and to regain elbow range of motion to allow her improved performance of self-care (grooming, personal hygiene) and full participation in household activities (cleaning, yard work).

The initial physical therapy evaluation was conducted 10 days post-onset and the findings are summarized in Table 1.

Initial Treatment Plan

Therapeutic exercise, cryotherapy

Physical Therapy Goals

Pain	1-2/10 worst
AROM	shld flex 115º, scaption 115º, elbow ext 0º-20º
Strength	4+/5 to 5/5 RUE
Function	restore preinjury capabilities to reach above shoulder level, lift, carry, perform personal care and household ADLs

A copy of the patient's magnetic resonance scan of the right elbow was obtained the following day. The radiologist's impressions were:

WESTARM Therapy Services,
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Table 1. Evaluative Findings

Pain	0/10 best, 10/10 worst over anterior shoulder and brachium with movement
Inspection	atrophy biceps and deltoid muscles, + elbow effusion, scapular protraction and winging right shoulder girdle
Palpation	large mass in elbow flexor musculature with associated tenderness
AROM	shld flex 0°-85°, scaption 0°-72°, elbow ext 0°-55°-145°
PROM	shld flex 0°-110°, scaption 0°-128°, elbow ext 0°-48°-145°
Strength	shld flex and abd 3-/5, supraspinatus 4+/5, elbow flex 3+/5 (painful), pronation 5/5 (painful)
Mobility	hypomobile caudal glenohumeral joint glide
Neurologic	unremarkable
Special tests	+ Yergason's test, + Lateral Slide test
Function	limited ADL's involving elbow extension and reaching overhead
Imaging	results not available to PT at time of evaluation. Copies of reports obtained the following day

1. Appearance of strain/contusion particularly in the anterior brachialis muscle with suspected large focal hematoma in its anterior portion with extension down to its insertion onto the ulna without detectable significant disruption of the attachment on the ulna.
2. Large amount of subcutaneous edema.
3. Moderate joint effusion at the elbow joint with suggestion of mild bone contusion in the anterolateral radial head.
4. Minimal enhancement in the triceps tendon at its insertion onto the olecranon suggesting the possibility of minimal intrasubstance tears in this region.

Subsequently the imaging films were requested by and made available to the physical therapist (Figures 1 and 2).

Although the patient could not recall a precipitating incident near the time of onset, the MRI was strongly suggestive of trauma. Evidence of trauma was discerned from the localized brachialis hematoma and edematous signal change in the radial head, with its associated joint effusion, consistent with a bone contusion. Table 2 summarizes the sequela of a muscular contusion.[4,5]

The plain radiographs of the elbow 2 days after onset of symptoms did not demonstrate evidence of the soft tissue injury. Radiography is a routine initial imaging study but is best at identifying bony, not soft tissue pathology. Generally, radiographs would not show definitive signs of muscular hematoma until 3 to 6 weeks postinjury and only in the presence of heterotopic bone formation.[4]

The patient's MRI study 4 days after onset showed a consolidated hematoma localized to the brachialis muscle. There were no signs of active bleeding at the time of imaging. The coupled findings of subacute hemorrhage and waning inflammation on the MRI made available to the physical therapist

Figure 1. T^2 image sagittal view right elbow.

Figure 2. T^1 image sagittal view right elbow.

Table 2. Phases of a Muscular Contusion

Crush Injury

↓

Degeneration Phase

Extravasation of blood between and within deep musculature
Inflammatory cell response
Necrosis muscle tissue
Formation hematoma

↓

Muscle Regeneration Phase

Hematoma & necrotic muscle tissue replaced by granulation tissue
Formation scar tissue from granulation tissue
Proliferation and differentiation satellite cells giving rise to myofibers
In severe injury, overproduction extracellular matrix and connective tissue
Capillary ingrowth

↓

Myositis Ossificans

(3 weeks)
Formation intramembranous bone
within muscle

↓

Remodeling Phase

Maturation regenerated muscle fibers
Reorganization fibrous scar

↓

Incomplete Functional Recovery of Muscle Tissue

11 days post-onset, led to the determination that range of motion and mobilization of the elbow was not contraindicated. It would not place the patient at a significant risk for further vascular disruption.

Treatment

Treatment at the initial physical therapy visit included AAROM and AROM exercises of the shoulder, forearm, wrist, and hand and cryotherapy. After reviewing the results of the patient's diagnostic imaging studies, AAROM and AROM of the elbow was added at the time of the second treatment session.

No significant changes were noted by the third treatment session within the span of 2 weeks. At that time nonthermal therapeutic pulsed ultrasound (1 MHz X 20% duty cycle X 0.5 W/cm^2 X 6 minutes) over the area of hematoma was introduced as well as high volt pulsed electrical stimulation at the humeroulnar joint for edema reduction. The revised treatment plan also included right glenohumeral joint caudal glide mobilization and humeroulnar distraction mobilization to address joint hypomobility issues, gentle contract-relax-stretching, and passive elbow extension stretching exercises. The patient progressed to upper body ergometer training, specific strengthening, and total arm exercises for the RUE to address deficits in muscular strength and endurance, scapular stabilization activities as well as moist heat and/or cryotherapy on a prn basis. The patient participated in a total of 13 physical therapy sessions over the course of 5 weeks. She was compliant with a home exercise program of ROM, stretching, and progressive resistive exercises with weights.

OUTCOMES

At the time of her discharge from physical therapy, the patient denied right elbow pain and noted shoulder pain rated 2/10 at worst with reaching overhead. The mass in the medial elbow flexors reabsorbed and only a small palpable mass < 0.5 cm. in diameter was noted laterally. Effusion and subcutaneous edema had completely resolved. Elbow AROM improved to 0º-6º-145º. Shoulder AROM was restored to preinjury levels and strength of the RUE musculature was assessed at 5/5 with the exception of strength of the long head of the biceps muscle at 4+/5. Functionally she was able to perform all desired ADLs except overhead work, eg, washing walls or hanging clothes, due to limited shoulder AROM. However, this was her functional level prior to this episode due to a long-standing shoulder injury unrelated to the current pathology. She was discharged with an independent home exercise program. Physical therapy goals were met.

DISCUSSION

This case report discusses the management of a patient diagnosed with an intramuscular hematoma and associated pathology. Diagnostic imaging was important to the physical therapy plan to correctly identify the lesions at the elbow, stage the injuries in terms of acuity, and guide the selection and timing of appropriate physical therapy interventions.

Magnetic resonance imaging involves the interactions of atomic nuclei within a strong magnetic field. The atomic nuclei, particularly hydrogen in the human body, align in the magnetic field. The field is then exposed to an electromagnetic energy, specifically radio frequency pulses, perpendicular to the magnetic field. The hydrogen nuclei absorb the energy causing them to be deflected into a higher energy state. When the radio frequency energy is removed, the hydrogen nuclei 'relax' returning to their lower energy state and alignment. The change in energy states results in emission of radiowaves that are then recorded providing information about the body tissues in which the hydrogen nuclei are contained.[6]

There are 3 primary pulse sequences commonly used. Time 1 (T1) refers to the longitudinal relaxation time required for a certain proportion of the tissue nuclei to realign with the magnetic field. Time 2 (T2) is the transverse relaxation time following application of the transverse RF energy pulse. If enough time is allotted between RF excitation phases, then all of the protons relax and the signals are not dependent on the longitudinal and transverse time constants. Images obtained under these conditions are called proton density weighted.[6]

When reviewing the magnetic resonance images for this patient it is important to know that acute hemorrhage shows bright on T_1 weighted images and dark to medium shades of gray on T_2 weighted images. Subacute hemorrhage shows moderate to high signal intensity on T_1 and T_2 images. Chronic hemorrhage shows variable intensity on T_1 but bright on T_2 weighted images. Edema and effusion have high intensity (bright) signals on T2 weighted and intermediate signals on T1 weighted and proton density images. Muscle has an intermediate intensity signal on T1 and T2 weighted as well as proton density images.[6]

Other diagnostic imaging options for this particular patient may have been computed tomography (CT). However, CT has limited capabilities for differentiating the histologic composition of tissues, particularly those of similar radiodensities, in this case, a consolidated hematoma versus surrounding muscle. Applying a soft-tissue window to the CT data displayed allows for greater identification of soft tissue anatomy.[6]

Diagnostic ultrasound could have been another imaging choice in this case. On ultrasound scanning, muscle is hypoechoic and images dark. Hemorrhage is hyperechoic and shows bright. Joint effusion presents as a thin hyperechoic line in contrast to adjacent cartilage, which is usually hypoechoic. Free fluid (edema), however, is anechoic and would not have been identified with ultrasound imaging nor would it have differentiated the radial head contusion. If myositis ossificans were an issue, soft tissue calcification typically is hyperechoic and returns a bright echo. Ultrasound has been reported to be as accurate as MRI for imaging muscles and can provide specific detail of the internal characteristics of muscle.[6]

The decision to begin range of motion and mobilization of the elbow was based on the MRI findings of no active bleeding at the site of the intramuscular hematoma as well as clinical signs consistent with staging the lesion in the subacute phase of healing. In animal models, it has been demonstrated that early movement leads to more rapid and extensive muscle regeneration than in immobilized muscles.[4,7]

Relative to the use of therapeutic ultrasound in the physical therapy treatment plan, one must be aware that ultrasound is contraindicated in an area of active bleeding but has been recommended for nonacute hematomas.[8,9] It is theorized that the nonthermal effects of pulsed ultrasound through acoustic microstreaming and acceleration of fibrinolysis accelerate reabsorption of a hematoma.[9]

The rationale behind the application of sensory level high voltage pulsed electrical stimulation to reduce subcutaneous edema is to induce a fluid shift through an altered concentration gradient.[10] After injury, proteins escape from the microvasculature. The negative active electrode (cathode) repels the plasma protein ions into the lymphatic channels removing them from the area of injury. The increased osmotic pressure within the lymphatic channels facilitates the flow of fluid from the interstitial spaces into the lymphatic system.[11,12]

The profession of physical therapy is realizing widespread direct access and to meet these inherent responsibilities DPT and tDPT curricula as well as postprofessional continuing education programs include study in diagnostic imaging. This, in combination with the availability of digital imaging studies via health system computer networks and even the electronic transfer of medical records among practices, allows physical therapists ready access to pertinent diagnostic imaging information. Previously therapists were dependent upon patients or receptionists in physician offices reporting the diagnostic imaging results or at best receiving a copy of the radiologist's written report. We now have the opportunity and the responsibility to review the actual images and apply that knowledge to our understanding of the patient's diagnosis and prognosis leading to the development of a physical therapy treatment plan or decision to refer the patient to another medical practitioner.

In this particular clinical case, I believe the additional information the MRI films provided, beyond the given diagnosis of "right shoulder strain and right elbow hematoma" as stated on the referral, led to a more complete assessment and understanding of all of the involved pathologies by the physical therapist. In turn this contributed to the targeted treatments and the positive outcome of this case.

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Case Report
Rehabilitation of a Patient with Minimally Invasive Total Knee Arthroplasty

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ABSTRACT

The purpose of this case is to describe the evaluation and treatment of a patient with osteoarthritis of the right knee status post-minimally invasive total knee arthroplasty. The patient is a 57-year-old female with a gradual progression of degenerative joint disease of the right knee. Patient was referred to outpatient physical therapy 3 days status post-minimally invasive total knee arthroplasty. She was treated with passive, active assistive, and active range of motion; strengthening; patellar mobilizations; soft tissue mobilizations of the incision; balance activities; gait training; edema control with the use of cold modalities; home exercise program training; and patient/family education.

Key Words: computer-assisted minimally invasive total knee replacement, mini-incision total knee arthroplasty, minimally invasive total knee arthroplasty

INTRODUCTION

Total knee arthroplasty (TKA) is a widely used successful procedure in the management of degenerative joint disease of the knee. According to the American Academy of Orthopedic Surgeons (AAOS), there are approximately 300,000 total knee arthroplasties performed each year in the United States. From 1990 to 2002, the frequency of this surgical procedure has rapidly increased threefold.[1]

In the conventional surgical techniques for total knee arthroplasty, a 10- to 12-inch midline incision from an area proximal to the patella to distal to the tibial tuberosity allows for wide exposure of the joint. Some of the key components addressed through this wide exposure include ligament balancing, osseous preparation, component selection and sizing, and providing for proper alignment of the involved extremity. Ligament balancing and overall alignment for implant success was established by Insall and others.[2] In order to allow eversion and subluxation of the patella, the surgeon may perform medial parapatellar arthrotomy, medial subvastus dissection, or quadriceps tendon splitting. There has been criticism of medial parapatellar arthrotomy due to the potential for disruption to the extensor mechanism and descending genicular artery. Thus, potential for fracture increases as does the risk for osteonecrosis.[3] The procedures may predispose the patient to various complications including patellar tracking problems.

Minimally invasive total knee arthroplasty (MIS TKA) is a surgical procedure allowing an orthopaedic surgeon to perform a total knee arthroplasty through a smaller incision avoiding invasion of the extensor mechanism and suprapatellar pouch and avoiding patellar eversion. Minimally invasive unicondylar total knee arthroplasty was introduced by Repicci in the early 1990s.[2,4] In comparison to the traditional 8- to 12-inch incision, the minimally invasive incision measures 4 inches. This new technique is referred to as the 'quadriceps-sparing technique' because it avoids trauma to the quadriceps muscles. Not only are the quadriceps spared, but there is limited soft tissue dissection overall. With the 'suspended leg technique,' as reported by Bonutti et al, the weight of the limb in a flexed position allows for the benefits of soft tissue balancing with minimal trauma to the extensor mechanism.[5] The patella is pushed to the side rather than everted. Proposed benefits of minimally invasive total knee arthroplasty include decreased postoperative pain, decreased blood loss, shorter hospital stay, earlier mobility, a reduction in scar tissue, and an accelerated recovery requiring less rehabilitation. The normal physiologic and psychologic responses to trauma from surgery are decreased.

Various types of MI TKA surgeries exist. The subvastus approach is completed by the surgeon below the vastus medialis obliques muscle and tendon. The muscle and tendon are not cut. Rather, they are lifted by specialized equipment and with specialized physician techniques. Incision length varies from 3 to 4 inches. In a study by Aglietti and colleagues, the researchers found "no difference between the mini-subvastus and quadriceps-sparing approach in relation to short term recovery or early results."[6] However, Pagnano and associates advocate for the subvastus approach as it preserves the quadriceps attachments, decreases disruption to the suprapatellar pouch, does not require patellar eversion, and allows for reliable and efficient knee closure.[7]

Computer-guided navigation is used with the minimally invasive total knee arthroplasty procedure in order to increase accuracy of the procedure. In 1992, William Barger performed the first computer-assisted total hip replacement.[8] Frederich Picard, a French surgeon, performed the first computer-navigated total knee replacement. The U.S. Food and Drug Administration approved the first computed tomography based knee replacement in 2001. Since that time, the technology has been used much more readily. "The use of computer navigation in orthopaedic surgery allows for real time intraoperative feedback resulting in higher precision of bone cuts, better alignment of implants and extremities, easier fracture reductions, less radiation and better documentation than what is possible in classical orthopaedic procedures."[9] In a meta-analysis of 13 studies, Bathis and colleagues reported 93.9% of accurately placed prosthetic implants using computer-assisted surgery versus 75.6% using conventional techniques.[10] In a second meta-analysis, Bauwens et al reported lower risks of malalignment with computer-assisted technology.[11] Accuracy

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in the implant placement is critical to the long-term success of the total joint replacement.

Using computer-guided navigation, instrumentation can be precisely positioned for ideal alignment of the components. The navigational system tracks the surgical instruments in real time giving immediate feedback. A 3-dimensional image of the patient's anatomy is given by the computer. Implant position is projected onto a screen. Hence, there is less dissection required and greater precision in placement of the components. Due to even weight distribution, there is an extension in longevity in the implant components with lower wear rate. Kim et al reported the computer-guided navigation system allowed a more reliable reproduction of the mechanical axis with improved coronal alignment.[12] Seon et al compared navigated-assisted MI TKA with traditional TKA and reported improved Western Ontario and McMaster Universities (WOMAC) pain and function score, range of motion for knee flexion, and less problems with component alignment one year postoperatively.[13] With computer-guided navigation, a numeric measurement of a patient's joint laxity can be made to improve ligament balancing techniques. Because of the elimination of the mechanical jigs, computer-assisted surgical procedures reduce the trauma to the joint.[14] Additionally, the potential for fat embolism syndrome is eliminated because of the elimination of the intermedullary rod.

The tracking systems used vary from optical tracking to electromagnetic tracking. Optical tracking uses a light-emitting diode attached to the patient or camera.[8] Utilizing electromagnetic tracking, electromagnetic markers are excited in an electromagnetic field, which creates an image of the patient's anatomy and limb alignment. The computer correlates the patient's anatomy with the appropriate implant size and type. At this point, the computer plans for the depth and orientation of the bone cuts and soft tissue tension.[8] Step-by-step analysis can be made for determination of the ultimate clinical outcome. The more recent imageless-guided systems using electromagnetic field transmitters and detectors have certain advantages over the imageless-guided systems with bulky, problematic arrays.[15]

Several other particulars assist in improving outcomes for the MI TKA patient. Miniaturized surgical instrument assist to compensate for visualization issues related to the smaller incision.[16] Newer components of the total knee replacement include tantalum. This material allows quicker bone ingrowth. Tantalum trabecular metal mimics real bone with both its properties of stiffness and porosity. The thigh tourniquet is eliminated due to the elimination of bone cement. Approximately 60% of muscle strength can be lost because of the application of the thigh tourniquet during the traditional total knee replacement procedure.[17] Rosenberg and Scuderi have emphasized the importance of surgeons learning the procedure with incremental changes in their surgical environment and techniques.[18,19] Scuderi has also suggested that the success of MI TKA is a combination of multiple factors, such as the surgeon's skills, preoperative management with patient education, anesthetic variables, and optimal team rehabilitation.[20]

Like any surgery, MI TKA has the potential for several complications. Improper component placement and neurovascular compromise can occur due to the smaller incision allowing less visualization by the physician. Dalury and associates reported 4 of 30 MI TKA patients had tibial varus malalignments as compared with no malalignments in the 30 patients receiving traditional knee replacements.[21] Fisher et al retrospectively compared traditional total knee arthroplasty with open and minimally invasive unicondylar total knee replacements via radiographs. They found most accuracy in component alignment in the traditional approach followed by the open unicondylar, and lastly, the minimally invasive unicondylar replacements.[22] Shakespeare et al specifically reviewed the accuracy of 224 Oxford knees using 16 criteria and found 18/224 (0.08%) had femoral component alignment problems and 36% had the tibial tray implanted too far anterior. In 3/224 (0.013%) of the cases, the depth of the cement under the keel was excessive because of osteoporotic bone. The only loosening reported occurred in the femoral component in 1 case resulting from a patient fall.[23] Fractures and nerve injuries also have been reported. As with the traditional procedures, the patient may experience blood loss, potential for blood clotting, infection, and rejection of the prosthetic components. Because of the compromised physician visualization, problems can occur when attempts are made to retrieve extruded cement. Keene et al reported on a 90° ball probe and its successful use in cement retrieval for the unicondylar minimally invasive total knee replacement.[24] Scuderi et al proposed the following contraindications to MI TKA, including patella baja, knee flexion contractures, and varus-valgus deformity.[25]

Studies of MI TKA reveal results to justify the use of this type of surgery. Laskin reported on excellent clinical and radiographic results on a 2-year follow-up of 100 patients who had a mini-midvastus capsular incision with an average length of 10.5 cm with exclusions of those with severe valgus deformity and BMI > 40.[26] Ohnsorge et al reported significantly better results with 250 MI TKA patients with regard to pain and function.[27] Minimally invasive patients had 115° of knee flexion at 6 weeks versus 100° for the traditional total knee arthroplasty group. In addition, on the second day postoperatively, the minimally invasive group required less than half of the morphine-equivalent dose.

There is little physical therapy literature regarding the rehabilitation of the patient with MI TKA. As more orthopaedic surgeons become trained in this procedure, it is important that the rehabilitation team be apprised of methods to provide efficient, quality rehabilitation for patients electing minimally invasive surgery. The purpose of this case report is to describe the evaluation and treatment of a patient with right knee degenerative joint disease status post-minimally invasive total knee arthroplasty.

PATIENT DESCRIPTION

The patient is a 57-year-old, ectomorphic homemaker with the diagnosis of right knee degenerative joint disease status post-minimally invasive total knee arthroplasty. Patient reported a gradual progression of arthritis with progressively increased pain of the right knee, decreased range of motion and function, and decreased ability for recreational sports including golfing, bowling, and walking. Patient stated trying cortisone injections and a trial of Synvisc without success. Radiographic reports indicated genu varum bilateral knees, joint space narrowing, and osteophytes. There is no history of previous arthroscopic knee surgeries. No preoperative physical therapy was reported. Patient reported a date of surgical intervention 3 days prior to beginning outpatient physical therapy. She was an inpatient for a total of 3 days. Immediately following surgery, the patient received inpatient physical

therapy and the use of a continuous passive motion machine for 6 hours per day. Inpatient rehabilitation consisted of 30 repetitions of each of the following exercises: heel raises, toe raises, standing multi-hip exercises for flexion marches, extension, and abduction, and standing hamstring curls holding for one second. The cross-over extension stretch was described as the surgical lower extremity being placed on a bolster and crossed by the nonsurgical lower extremity for a total of 5 repetitions. This position was held for 1 minute, followed by a 15 to 20 second rest period. Other exercises included 30 repetitions of short and long arc quads, quad sets over a bolster, and gluteal sets holding for 3 seconds, heel slides holding for 3 to 5 seconds, ankle pumps holding for 1 second, straight leg raises holding for 1 to 3 seconds, and supine hip abduction. The continuous passive motion machine was used 6 hours per day in the hospital. She immediately received gait training with a straight cane with weight bearing as tolerated. On the third postsurgical day, the patient returned home and continued with continuous passive motion machine use and her exercises as previously instructed. At the time of discharge, her range of motion was -1° to 123° and the CPM was set for 0° to118°. Hospital discharge instructions included patient to call the orthopaedic surgeon if temperature increases greater than 101°F, with incisional erythema, edema, or drainage; if pain is not relieved by pain medications; if nausea or vomiting occurs; and with the onset of chest pain, shortness of breath, or calf pain. She was instructed to continue using the CPM for 2 to 3 hours per day, 1 to 2 times per day, until her knee flexion reached 120°. Instructions for home activity level were based on patient tolerance. Kneeling was allowed with padding. The patient was to continue using pain medications as needed but instructed not to drive when taking prescription pain medications. She was allowed to shower, but the incision had to be covered for the first 2 weeks. The incision was allowed to be open to air or dry dressing as needed with removal of the steri strips after 2 weeks.

On the fourth postsurgical day, she was seen for an outpatient physical therapy evaluation. Her complaints of pain of the right knee ranged from 2/10 today and at best to 8/10 at worst (0-10 pain scale). A numeric pain rating scale was found to be both reliable and valid in older, cognitively intact persons with musculoskeletal problems.[28] Along with pain, she complained of stiffness of her knee. She reported a surgical history of hysterectomy in 1984. Patient denied the use of TED hose, but she reported using medications for blood clot prevention per physician orders. Current medications included Estrogen, Celebrex, Vicodin ES 1 to 2 tablets every 4 to 6 hours, and Lovenox. Forty milligrams of Lovenox was ordered by the physician for 2 weeks. Upon completion of the Lovenox, the patient was instructed to take 325 milligrams of Ecotrin for the next 2 weeks. Physician precautions for medication included no more than 5 Vicodin per day and no more than 4,000 milligrams of acetaminophen in 24 hours because it is contained in the Vicodin. The patient reported that she was able to immediately perform a straight leg raise following surgery. Lower extremity function was reported on "The Lower Extremity Functional Scale" (LEFS) from J. Binkley, P. Stratford, S. Lott, and D. Riddle. This functional tool was found to be reliable and when compared to the SF-36, construct validity was supported.[29] Patient reported 'extreme difficulty or the inability to perform' usual housework, hobbies, recreational activities, squatting, heavy home activities, running on even and uneven ground, hopping, and making sharp turns while running fast. Standing for 1 hour and walking 1 mile was rated as causing 'quite a bit of difficulty' on the scale. The patient stated 'moderate difficulty' with donning and doffing shoes and socks, lifting objects from the floor, car transfers, walking 2 blocks, and rolling over in bed. Patient described 'a little bit of difficulty' with shower transfers, ascending and descending 1 flight of stairs, and sitting for 1 hour. Patient denied difficulty with walking between rooms. Her total LEFS was 25 out of 80. Her reported goals were to resume a recreational walking program, golfing, and bowling.

PHYSICAL THERAPY EVALUATION

At the time of the initial evaluation, the patient presented with -10° to 90° AROM and -5° to 120° PROM on the involved, right knee in supine compared with -3° to 135° AROM on the uninvolved, left knee. Range of motion measurements were taken with the axis at the lateral epicondyle of the femur, the proximal arm aligned with the lateral midline of the femur using the greater trochanter as a reference, and the distal arm aligned with the lateral midline of the fibula using the lateral malleolus and fibular head for reference.[30] Goniometric measurements of the knee have been found to be reliable and valid.[31] Increased edema was noted on the right measuring 3.4 cm greater at the mid patella level, 4.2 cm greater when measured 4 inches above the mid patella, and 5.6 cm when measured 4 inches below the mid patella in supine. Girth measurements using a tape measure have high intra- and inter-tester reliability.[32] Strength of the quadriceps and hamstrings was rated as 2+/5 on the right compared with 4+/5 on the left using Florence Kendall's method of manual muscle testing. In general, reliability of manual muscle testing has not be well established in the literature.[33,34] Leg length was equal in standing and supine. Patellar alignment and tracking were normal. Patellar mobility was decreased in all directions. Sensation was intact when assessing with light touch to the lower extremity dermatomes.[35] Palpation revealed moderate incisional tenderness. The incision was healing without drainage present. Steri strips were in place. The patient ambulated with a straight cane with weight bearing as tolerated. In the subjective gait analysis, an antalgic gait was noted.[36] Physical therapy goals were to: (1) decrease right knee pain to 1-2/10, (2) increase AROM of the right knee to 0° to 130°, (3) increase strength of the quadriceps and hamstrings to 4+/5, (4) normalize gait without a device, (5) reciprocating gait on stairs, and (6) return to independent activities of daily living, instrumental activities of daily living, and recreational activities. Goals 1-5 were set for achievement in 2 to 4 weeks. Goal 6 was set for achievement in 6 weeks.

COURSE OF TREATMENT

After the evaluation, the patient began treatment. Home exercises from the hospital discharge and home cold pack use were reviewed. She was instructed in cold pack application with a dry towel between the skin and the cold pack and application for 15 minutes at a time with the involved lower extremity positioned in supine and elevated above the level of the heart.[37] She received passive range of motion for knee extension and flexion. Passive range of motion for knee extension was performed with the patient positioned in supine and the physical therapist manually applying pressure just proximal and distal to the knee with a towel placed at the posterior ankle. Passive knee flexion was performed with manual application further into knee flex-

ion with a heel slide. She began bicycling on the Schwinn Airdyne with all extremities for implementation of a cardiovascular exercise and to increase right knee flexion. Bicycle seat height was placed with the pin in seat height setting #4. Patient was issued instructions for self range of motion techniques including knee extension stretch with the patient seated and the right lower extremity outstretched on a chair with the plantar foot fixed to the back of the chair. The patient was given knee flexion range of motion in a rocking chair. Table 1 illustrates the exercise progression throughout rehabilitation.

On day 2, the patient received exercises as indicated on the progressive resistive exercise sheet, passive range of motion for knee flexion and extension, and application of a cold pack as previously described.

On the third visit following the initial evaluation and treatment, she reported decreased ability to sleep, sleeping in one hour increments. With medication use, reported pain level was 6-7/10 above and below the knee joint at the "hip, thigh, and ankle." Patient progressed with exercises as listed in the exercise chart. She continued with passive range of motion for knee extension and flexion. Cold pack with elevation of the lower extremity was applied after the exercise program secondary to edema at the mid patella 0.8 cm greater than the initial measurement of 40.8 cm. After cold pack was removed, edema decreased to 36.0 cm. Edema was measured around the mid-patella with the patient positioned in supine and by the same physical therapist with the same standard tape measure.

During visits 4 and 5, the patient's exercise program was progressed per the exercise grid. On the fourth outpatient visit, patellar mobilizations and contract-relax techniques were added to achieve further gains in ranges of motion for flexion and extension. At the fifth postoperative visit, the patient complained of increased right ankle and calf pain which increased to 6-7/10 with activity. Observable ecchymosis was noted at the circumference of the ankle. A negative Homan's Sign was seen. Negative signs and symptoms of a blood clot were noted including no significant warmth, calf tenderness, or calf edema. After completing the new objective data, she stated she twisted her ankle in the continuous passive motion machine. By the end of the fourth postoperative visit, at the first full week of outpatient physical therapy, the patient presented with 2-3/10 right knee pain and -5° to 123° of active range of motion. She was able to add weights to some of the exercises as listed in Table 1.

During the second full week of outpatient physical therapy (visits 6-8), the patient progressed with her therapeutic exercises, aggressive passive range of motion, and patellar mobilizations. On the eighth day, an additional 2 minutes was added to the activity. At the end of this week, pain level was a consistent 2/10. Active range of motion measured -6° to120°. Passive range of motion measured -3° to 127°. Reported improvement in ability to sleep was noted. Strength increased to 4+/5 for the quadriceps and 3+/5 for the medial and lateral hamstrings. Antalgic gait on level surfaces and nonreciprocating stair negotiation persisted. The main concern at this point in rehabilitation was the lack of terminal knee extension.

At visit 9, patient achieved passive range of motion from 0° to135°. During this week (visits 9 – 11), the patient continued with exercises as listed on the exercise sheet and continued passive range of motion. Unilateral balance activities were added with eyes open (EO) on level (L) surfaces for 1 minute without loss of balance (LOB). Shoes were in place for all balance activities. The patient complained of pain ranging from 1-5/10. Pain increased at the end ranges of knee flexion. Functional complaints included decreased ability to sleep and perform lifting and carrying activities. The patient began to improve for tolerances to cleaning floors, dishes, and cooking. She had not resumed golf or bowling yet.

On visit 12, the patient reported to the physician's office for a follow-up visit. She stated that the physician told her she was in the upper 20% of his patients in this stage of rehabilitation, flexion was "good," and extension was "acceptable." The physician released her to resume driving and using the home elliptical machine. A new prescription was received. The patient's focus was consistency in achieving terminal knee extension. She continued her exercise progression. The use of the straight cane was discharged. The patient continued with exercises, passive range of motion, and cold pack use. Balance activities were progressed to uneven surfaces using the Airex pad. Superior, inferior, medial, and lateral patellar mobilizations were reviewed so that the patient could continue with them as part of the home exercise program. Transverse friction massage was initiated as the incision was completely healed and adhesions were beginning to be noted. Observation of gait revealed a normal gait pattern without deviations. The patient demonstrated reciprocating stair negotiation with ascension, but nonreciprocating gait with descension.

On visits 13 and 14, the patient's exercises were progressed and she continued with PROM. In addition, the patient received transverse friction massage one last time with instructions for the home program on visit 14. During the fifth week of outpatient rehabilitation, the patient rated pain 0-4/10, active range of motion was -3° to 125°, passive range of motion was 0° to 134°, and quadriceps and hamstring strength measured 4+/5 and 4/5, respectively. Sleeping tolerance remained a problem at this time.

During week 6 (visits 15-17), she continued with PROM and exercise progression. Pain continued to decrease to 1-2/10. Active range of motion of the knee was -4° to 128°. Hamstring strength increased to 4+/5. The patient began cautiously reciprocating stair negotiation when descending stairs. Functionally, she had resumed all housework duties. She complains of decreased ability to squat for daily activities. The patient had not attempted any recreational activities at this time.

Week 7 (visits 18-20) progressed with passive range of motion, progressive resistive exercises, and additional instructions in prone hangs. Prone hangs are described as prone knee extension stretching with a towel roll at the distal thigh and the lower extremity hanging off of the mat table.[38] The patient initially tolerated 5 minutes and was instructed to progress as tolerated for her home exercise program. Prone hangs were issued in order to address the new reports of 7/10 pain of the anterior right ankle pain. As she attempted to achieve terminal knee extension with her clinic exercises, she was observed performing forceful dorsiflexion of the ankle. Prone hangs allowed her to work on her terminal knee extension without affecting the ankle. Objective data changes included increased hamstring strength to 5/5. Quadriceps strength remained 4+/5. Active terminal knee extension remained -2° but passively measured 0°.

During the last 2 weeks of physical therapy, the patient weaned to 2 times per week instead of 3 with the continuation of

PROM and exercises as charted. The patient complained of occasional medial knee pain at a 2/10 level. The patient was no longer having any symptoms in her ankle complex. She was able to perform reciprocating stair negotiation with both ascension and descension. Active range of motion was 0° to 133°. The patient was able to golf 9 holes with a cart used in between holes. She was independent and safe in her ability to squat. Right lower extremity strength was 5/5 (WNL) except 4+/5 for the hip external rotators and gastrocnemius. She completed the LEFS and scored 59/80. The patient rated 'extreme difficulty or unable to perform activity' for running on uneven ground and making sharp turns. The patient rated running on even ground and hopping as 'quite a bit of difficulty' and standing for one hour as 'moderate difficulty.' 'A little bit of difficulty' was reported with performing any usual work, housework, or school activities, usual hobbies, recreational, or sporting activities, performing heavy activities around the home, walking a mile, and going up and down a flight of stairs. All other functional activities were rated as 'no difficulty' on the functional score. The patient did not miss any scheduled sessions. She attended 24 out of the scheduled 24 physical therapy visits. Clinic exercises were reviewed for the home exercise program throughout her treatment sessions and constant updates were given. The patient was independent and safe with these activities. Gray theraband was issued for progression with the home exercise program.

Table 1. Progressive Resistive Exercise Sheet

VISIT	1	2	3	4	5	6	7	8	9	10	
Schwinn Bike	5'	5'	5'	5'	6'	7'	7'	7'	7'	7'	
PROM	X	X	X	X	X	X	X	X	X	X	
DTR	---	2x10	2x10	2x10	2x10	2x10	3x10	3x10	3x10	3x10	
Standing Multi-Hip (4-ways)	---	® 0# 10x	® 1# 2x10	® 2# 2x10	® 2# 2x10	® 3# 2x10	® 3# 2x10	Bilat 3# 2x10	Bilat 3# 3x10	Bilat 3# 3x10	D/C HEP
Standing Ham Curls ®	---	0# 10x	0# 2x10	2# 2x10	2# 2x10	3# 2x10	3# 2x10	3# 2x10	3# 2x10	3# 2x10	
Supine Heel Slides	---	 10x	rope 2x10	rope 2x10	rope 2x10	rope 2x10	rope 2x10	rope 3x10	rope 3x10	rope 3x10	
SAQ	---	0# 10x	0# 2x10	1# 2x10	2# 2x10	3# 2x10	3# 2x10	5# 2x10	8# 2x10	5# 2x10	
QS Hold 5"	---	 10x	 2x10	 2x10	 2x10	 2x10	 3x10	 3x10	 3x10	 3x10	
Hip Abd sup or side	---	0# 10x sup	0# 2x10 Sup	0# 2x10 sup	0# 2x10 sup	0# 2x10 side	5# 2x10 side	3# 2x10 side	3# 2x10 side	3# 2x10 side	
SLR	---	0# 10x	0# 2x10	0# 2x10	2# 2x10	3# 2x10	3# 2x10	3# 2x10	3# 2x10	3# 2x10	
LAQ	---	0# 10x	0# 2x10	1# 2x10	2# 2x10	3# 2x10	5# 2x10	5# 2x10	5# 2x10	5# 2x10	
Patellar Mobs (4-ways)	---	---	---	X	X	X	X	X	X	X	
Partial Squats	---	---	---	2x10	2x10	2x10	2x10	2x10	2x10	2x12	
TKE T-band	---	---	---	---	Gr 2x10	Gr 2x10	Gr 2x10	Gr 2x10	Gr 2x10	Gr 2x10	
Prone Hip Ext	---	---	---	---	---	---	---	0# 10x	3# 10x	3# 2x10	
Leg Press	---	---	---	---	---	---	---	160# 2x10	160# 2x10	160# 2x10	
Side Hip Add	---	---	---	---	---	---	---	---	0# 10x	0# 2x10	
Seated Ham Curls (T-band)	---	---	---	---	---	---	---	---	Gr 10x	Gr 2x10	

Table 1. Continued.

VISIT	11	12	13	14	15	16	17	18	19	20	21
Schwinn Bike	8’	8’	8’	8’	10’	10’	10’	10’	10’	10’	10’
Treadmill Mph Incline	5’ 1.2 1%	7’ 1.5 1%	7’ 1.5 1%	7’ 2.0 1%	8’ 2.0 1%	8’ 2.0 1%	8’ 2.0 1%	10’ 2.2 1%	10’ 2.2 1%	10’ 2.2 1%	10’ 2.2 1%
Standing TKE (T-band)	Gr 2x15	Blue 2x15	Blue 2x15	Blue 2x15	Blue 2x15	Blk 2x10	Blk 2x10	Blk 2x10	Blk 2x15	Blk 2x15	Blk 2x15
STR	3x10	3x10	3x10	3x10	3x12	3x15	3x15	3x15	3x15	3x15	3x15
Partial Squats 5”	10x	2x10	2x10	2x10	2x15	2x15	2x15	2x15	2x15	2x15	2x15
Leg Press	160# 2x10	180# 2x15	200# 2x10	200# 2x15	200# 2x15	240# 2x15	240# 2x15	240# 2x15	240# 3x15	240# 3x15	240# 3x15
Seated Ham Curls (T-band)	Gr 2x15	Blue 2x10	Blue 2x15	Blue 2x15	Blue 2x15	Blue 2x15	Blue 2x15	Blue 2x15	Blk 2x10	Blk 2x10	Blk 3x10
LAQ	5# 2x15	5# 2x15	5# 2x15	5# 2x15	5# 2x15	5# 2x15	5# 2x15	5# 2x15	5# 3x15	5# 2x15	7.5# 2x10
SLR	3# 2x15	3# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 4x10	5# 2x10
Prone Hip Ext	3 # 2x15	3# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 4x10	5# 2x10
Side Hip Abd	3# 2x15	3# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 4x10	5# 2x10
Side Hip Add	1# 2x15	3# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 4x10	5# 2x10
QS Hold 5”	30x	30x	30x	30x	30x	30x	30x	30x	30x	30x	30x
Prone Ham Curls	3# 2x10	3# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 2x15	4# 4x10	5# 2x10
Heel Cord Pro-Stretch Hold 30”	3x	3x	3x	5x	5x	5x	5x	5x	5x	5x	5x
Sanddune March	---	3’	3’	3’	3’	3’	3’	3’	3’	3’	4’
SAQ	5# 2x10	5# 2x10	5# 2x10	5# 3x15	6# 2x10	7.5# 2x10	7.5# 3x15	7.5# 3x15	7.5# 3x15	7.5# 3x15	7.5# 3x15
PROM	X	X	X	X	X	X	X	X	X	X	X
Patellar Mobs	X	X	D/C HEP	---	---	---	---	---	---	---	---
Dynadisc Balance	---	---	---	---	---	---	---	---	---	---	1’EO BLE
Unilateral Standing Balance Level=L Airex=A Eyes open=EO Eyes closed= EC	EO L 1’ ---	EO A 1’ EC L 12”	EO A 1’ EC L 28”	EO A 1’ EC L 23”	EO A 1’ EC L 49”	EO A 1’ EC L 1’	EO A 1’ EC L 55”	EO A 1’ EC L 55”	EO A 90” EC L 47”	EO A 1’ EC L 17”	EO A 1’ EC L 44”

EO=eyes open, EC=eyes closed, L=level surfaces, A=Airex pad (uneven surfaces)

Table 1. Continued.

VISIT	22	23	24
Schwinn Bike	10'	10'	10'
Treadmill Mph Incline	10' 2.5 1%	10' 2.5 1%	10' 3.0 1%
Standing TKE (T-band)	Gray 2x10	Gray 2x15	Gray 2x15
STR	3x15	---	3x10
Partial Squats 5"	2x15	2x15	2x15
Leg Press	240# 3x15	260# 3x10	260# 3x15
Seated Ham Curls (T-band)	Blk 2x15	Blk 2x15	Gray 2x10
LAQ	7.5# 2x10	7.5# 2x15	7.5# 2x15
SLR	5# 2x15	5# 2x15	5# 2x15
Prone Hip Ext	5# 2x15	5# 2x15	5# 2x15
Side Hip Abd	5# 2x15	5# 2x15	5# 2x15
Side Hip Add	5# 2x15	5# 2x15	5# 2x15
Prone Ham Curls	5# 2x15	5# 2x15	5# 2x15
Heel Cord Prostretch Hold 30"	5x	5x	5x
Sanddune High March	3'	3'	3'
SAQ	10# 2x10	10# 2x15	10# 2x15
Dynadisc Balance	(L) 60" ® 25"	(B) 1'	(B) 1'
Unilateral Balance	EC A 1'	EC A 1'	EC A 1'

OUTCOMES

By the discharge date, which occurred at 2 months, all established goals were achieved. However, looking at the initial physical therapy goals, it took a longer time frame to achieve most of the individual goals than initially expected. Reassessment of each goal was performed in the same manner as the initial examination. To achieve the first goal of pain less than 2/10, it took 16 physical therapy visits (6 weeks). The patient achieved consistency in the measurement of active knee extension to flexion during the seventh and eighth weeks of physical therapy. The patient met the 4+/5 goal for strength of the quadriceps and hamstrings at week 6. During the eighth week of outpatient physical therapy, quadriceps and hamstring strength were normal (5/5). The fourth goal, normalized gait without a device, was the only goal achieved during the initially established time frame of 4 weeks. Goal #5 for reciprocating stair negotiation was achieved for ascension during the fourth week of rehabilitation. During the sixth week, the patient began to cautiously perform reciprocating descension of stairs. Descension was normalized during the remaining 2 weeks and by discharge from physical therapy. The functional goals of squatting, golfing, and normalizing activities of daily living were met during the last week of rehabilitation. The LEFS increased 34 points and 42.5%. The patient was independent and safe with her home exercises. She was able to reproduce all portions of the clinic exercise progression without extrinsic cues.

DISCUSSION

This case exemplifies the successful rehabilitation of the patient with MI TKA. The patient description and the correlation with the literature varies. For example, the patient in this case study had both corticosteroid and Synvisc injections. Neither treatment was beneficial to her on a long-term basis. This correlates with a study by Leopold and colleagues. The authors performed a prospective, randomized study and reported no change in function or pain after a 6-month period following corticosteroid and hyaluronic injections. There was a significantly decreased response in the women patients.[25] The characteristics of the patient who would successfully benefit from MI TKA correlated with a study by Tenholder et al who recommends that thin woman with a low body mass index, narrow femur, and good preoperative range of motion as the ideal patient for a minimally invasive total knee arthroplasty.[39] Her ability to achieve an immediate straight leg raise following the surgical procedure correlates with the research. Laskin and associates reported the MI TKA patient performing an independent straight leg raise at 1.2 days compared to 3 days for the traditional total knee arthroplasty.[25] The patient in this case report did not experience any of the proposed complications of MI TKA, such as neurovascular compromise and suboptimal positioning.[21] Her final measurements of knee flexion were higher than the expected measurements for a traditional total knee replacement patient. In addition, she exceeded the range of motion achievements described by several authors. Aglietti et al reported knee flexion ranges from 117° to 119° after 3 months following surgery.[6] Ohnsorge et al reported knee flexion ranges at day 3 was 75° and at 6 weeks was 115°.[27] Haas et al reported knee flexion ranges at 6 weeks, 12 weeks, and 1 and 2 years postoperatively were 111°, 122°, and 125°, respectively.[40] Seon et al reported average flexion was 131.9° 1 year postoperatively.[13] It will be necessary to contact the patient in the

future to assess whether she maintains her knee flexion similar to the results reported by Seon and colleagues.

In a study by Berger et al, 48 of 50 patients with a mean age of 68 years receiving MI TKA were able to return home the same day of surgery meeting established discharge criteria, with only 3 readmissions unrelated to early discharge.[41] Although this patient was not readmitted for complications, she did not achieve the criteria of the same day hospital discharge. In addition, the duration of physical therapy treatment following the surgical procedure was not significantly different than that of a patient receiving a traditional total knee arthroplasty.

As Tria and associates stated "It is also of paramount importance to remember that the main goal of any new technology is to advance the science of medicine without compromising the ultimate result for the patient."[4,16] "Ultimately, successful outcomes are not measured by the length of the incision or duration of recovery time but rather by the low rates of revision surgeries and implant performance over a long time period."[42]

This case report provides one example of rehabilitation following MI TKA. Evidence-based medicine for the rehabilitation parameters following MI TKA is scarce. It is unclear if long-term polyethylene wear will be an issue relative to the prosthetic survival versus failure rate. The current literature alludes to the MI TKA patient requiring less pain medications. However, there are no well-designed, large scale studies to support this statement. Much of the literature focuses on flexion range of motion data. However, in this patient's case, achieving full knee extension presented as a greater problem. From a physical therapy standpoint, further well-designed, long-term, large scale studies will provide an assessment of physical therapy interventions in order to maximize effectiveness and efficiency and to acquire functional outcome success.

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sectionawards

James A. Gould Excellence in Teaching Orthopaedic Section Physical Therapy Award

Submission deadline: November 1

This award is given to recognize and support excellence in instructing OPT principles and techniques through the acknowledgement of an individual with exemplary teaching skills. The instructor nominated for this award must devote the majority of his/her professional career to student education, serving as a mentor and role model with evidence of strong student rapport. The instructor's techniques must be intellectually challenging and promote necessary knowledge and skills.

Outstanding PT & PTA Student Award

Submission deadline: November 1

The purpose of this award is to identify a student physical therapist and a student physical therapist assistant (first professional degree) with exceptional scholastic ability and potential for contribution to orthopaedic physical therapy. The eligible student shall excel in academic performance in both the professional and pre-requisite phases of their educational program, and be involved in professional organizations and activities that provide the potential growth and contributions to the profession and orthopaedic physical therapy.

PARIS DISTINGUISHED SERVICE AWARD

Submission deadline: November 1

This award is given to acknowledge and honor a most outstanding Orthopaedic Section member whose contributions to the Section are of exceptional and enduring value. The nominee shall have made substantial contributions to the Section in areas such as: professional recognition and respect for the Section's achievements, and advanced public awareness of orthopaedic physical therapy.

Richard W. Bowling—Richard E. Erhard Orthopaedic Clinical Practice Award

Submission deadline: November 1

The Purpose of this award is to acknowledge an individual who has made an outstanding and lasting contribution to the clinical practice of orthopaedic physical therapy as exemplified by the professional careers of Richard W. Bowling and Richard E. Erhard.

ROSE EXCELLENCE IN RESEARCH AWARD

Submission deadline: September 1

The purpose of this award is to recognize and reward a physical therapist who has made a significant contribution to the literature dealing with the science, theory, or practice of orthopaedic physical therapy. The submitted article must be a report of research but may deal with basic sciences, applied science, or clinical research.

For more information on all of these awards, please visit the Orthopaedic Section's web site at: www.orthopt.org/awards.php.

Call for Candidates

Dear Orthopaedic Section Members:

The Orthopaedic Section wants you to know of the several options available for service within the Section opening up in February, 2008. If you wish to nominate yourself or someone else, please contact the Nominating Committee Chair, Kyndy Boyle, at boylekyn@elon.edu. Due Date: September 1, 2007. Elections will be conducted the month of November.

Open Section Offices:

- **Treasurer:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2008.
- **Director:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2008.
- **Nominating Committee Member:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2008.

bookreviews

Coordinated by Michael J. Wooden, PT, MS, OCS

McFarland EG. Examination of the Shoulder: The Complete Guide. New York, NY: Thieme; 2006. 282 pp., illus, with companion DVD.

Edward MacFarland states in his preface that this manuscript was compiled with 2 purposes in mind. First, the intention was to provide a complete handbook for evaluation of the shoulder joint that may be used by any medical professional wishing to examine the shoulder clinically. Second, the author wished to assemble the full scope of research and expert opinion regarding the shoulder joint, in an effort to critically evaluate the ways in which we examine and diagnose pathology at this site. I will assert that Dr. MacFarland and his contributors were successful on all accounts, as this book proved to be exceptionally thorough in its material.

The text begins with a discussion of why the shoulder joint is innately a difficult joint to examine on many accounts. While the shoulder joint is often compared to the knee in its evaluation, the author asserts that it is much more like the spine in its complexity and ambiguity. The shoulder joint consists of 4 distinct joints and 21 separate muscles covering the structures beneath, making it difficult to palpate. Pain patterns, noises, and conditions presenting in the shoulder tend to be nonspecific, making a diagnosis difficult. As well, multiple pathologies may co-exist, some being normal and age-related, while others may be traumatic and problematic. Sifting through these overlapping issues is the aim of this text.

Chapter one overviews the general principles of the shoulder examination, including the history and symptom complaints, structural examination, neurovascular examination, and radiographic imaging. The chapter is comprehensive, presenting multiple charts with data regarding pain patterns, difficulty performing specific activities, history of onset, and mechanism of injury with various pathologies.

The second chapter is a comprehensive review of range of motion measures at both the GH joint and the scapulothoracic joint. The authors discuss normative data established in the literature, measurement of straight plane and combined functional movements, the relevance of scapular dyskinesis, and special tests for ROM. Chapter three describes multiple methods to measure strength at the shoulder, including manual muscle testing, hand-held dynamometry, and isokinetic testing. Each muscle is discussed individually, with various techniques, special tests, and functional relevance discussed.

The final 4 chapters of the text are divided to address specific pathologies at the shoulder joint: rotator cuff disease and impingement, instability and laxity, bicep tendon pathology and SLAP lesions, and pathology of the AC and SC joints. Each section addresses background on the disease processes, typical history and presentation, specific 'signs' and special tests, as well as presenting literature regarding accuracy of these tests and their clinical significance when used in combination.

The text includes a DVD, divided into chapters consistent with the book, in which the author demonstrates and narrates through specific techniques and tests reviewed in the manuscript. These demonstrations are helpful and complete, clarifying many of the less-familiar procedures.

This text is a comprehensive and user-friendly review of the shoulder joint. It is appropriate for use by physicians, both general and orthopaedic, and for the rehabilitation professional.

Amanda Blackmon, DPT

McMahon PJ. Current Diagnosis and Treatment: Sports Medicine. New York, NY: Lange Medical Books/McGraw Hill; 2007. 287 pp., illus.

This textbook deals with all aspects of caring for the occasional to the competitive athlete. It is intended for the physician, physical therapist, athletic trainer, and nurses who care for this population. The book is well organized and comprehensive. There are numerous tables in each chapter that summarizes key information. A wide variety of subjects are covered including the preparticipation physical. In this first chapter, most of the acute problems that may be encountered are presented. These range from sudden cardiac death to testicular torsion. Common dermatological disorders are also discussed. The effect of asthma, diabetes, chronic obstructive disease, and cardiovascular disorders on exercise is presented clearly. An excellent table is provided for the reader explaining how to minimize the hypoglycemic risk in a diabetic athlete.

Specific information related to specific injuries of the extremities and spine are covered in the subsequent chapters. Each of the chapters begins with the relevant anatomy. The prevention, clinical findings, treatment (surgical and nonsurgical), and prognosis for specific injuries are presented. The details of the examination are imparted clearly along with the thought process about differential diagnosis. Physical examination tests are depicted. Imaging studies are discussed relative to each disorder including what should be expected. Photos demonstrating specific pathology on x-rays, MRI, and CT scans are shown. Evidence-based material is provided throughout the text, for example, 98% of professional football players return to football after an isolated injury to the medial collateral ligament of the knee. The references cited are current as well.

An entire chapter is dedicated to concussions. The University of Pittsburgh Medical Center's sideline concussion cards are provided to help the examiner assess signs and symptoms of a concussion. The metabolic effects of a concussion are described. The use of imaging studies to rule out other pathology as well the limitations of current studies is discussed. Finding criteria for returning the athlete to play is difficult as over 20 management guidelines exist at this time. Acquiring baseline neurocognitive testing is recommended for a more accurate assessment of the athlete's status.

The chapter on the youth athlete deals with the unique aspects of this population. The effects of growth plate injuries are discussed in great detail. Specific injuries such as slipped capital femoral epiphysis, legg-

calve-perthes disease, and Koehler disease are also presented. The number of pitches per week is given for each age group to help prevent Little League shoulder as well as other shoulder pathologies associated with throwing.

Injuries Specific to the Female Athlete is the title of the tenth chapter. Here the female athletic triad (amenorrhea, disordered eating, and osteoporosis) is presented. Other conditions that are more common in females than males include ACL injury, patella femoral disorders, multiple direction shoulder instability, and stress fractures. These are discussed individually. The benefits and contraindications of exercise and pregnancy are presented.

General guidelines are given for the rehabilitation of the various mentioned injuries, as well as precautions and rehabilitation goals such as strengthening and returning range of motion. This text does not cover specific techniques to reach these goals. There is a chapter dedicated to rehabilitation principles that does provide some detail about exercise, flexibility, mobilization, and functional rehabilitation of the athlete. Improving speed, agility, and power are addressed. The criteria for return to sport activity are also provided. In this section, there is an excellent and concise summary about the various types of exercise and creating an exercise prescription.

This book provides information about the examination and treatment of an occasional to elite athlete. A particular strength of this text is the large number of tables available that provide important and concise information. The illustrations are clear. The evidence for certain interventions is provided, and in cases where there is either minimal evidence or controversy exists, this is acknowledged.

Jeff Yaver, PT

Baratz ME, Rosenwasser MP, Adams BD, Kozin SH. Wrist Surgery: Tricks of the Trade. New York, NY: Thieme; 2006. 235 pp., illus.

In this text, the 4 authors, who are hand surgeons, discuss a variety of surgical procedures for the treatment of wrist disorders. Each chapter is written to include indications, techniques of the procedure, 'pearls' of wisdom to approach the procedure, common pitfalls, postoperative care, and suggested readings. The illustrations that accompany each chapter are a helpful adjunct to visualize the procedures.

There are 72 surgical procedures discussed in total and organized into 7 sections. The first section is an overview of distal radius fractures. It includes 6 chapters which discuss closed reduction and percutaneous pin fixation, limited-open reduction and percutaneous pin fixation, intra-articular fractures treated with a dorsal plate, palmar fracture/subluxation, open treatment of a distal fracture with a fixed angle palmar plate, and open treatment of Galeazzi fractures. In the second section, the procedures to correct distal radius malunions and nonunions are reviewed. Four chapters are presented on the following techniques: extension osteotomy, dorsal and palmar osteotomy with iliac crest bone graft, palmar translation of the articular surface, and nonunion management. The third section is a discussion of techniques related to distal ulna fractures. Three chapters review open reduction and internal fixation of an ulnar styloid fracture and fractures of the ulnar head and neck.

The shortest section is the fourth section (2 chapters), which reviews procedures to correct distal ulnar nonunions by resection of the fracture with repair of the triangular fibrocartilage complex and with plate fixation. The fifth section details techniques related to the distal radioulnar joint. This section is divided into 4 subsections consisting of the unstable distal ulna (head intact), arthritis, unstable distal ulna (post Darrach), and ulnocarpal abutment. In correcting the unstable distal ulna with the head intact, the following techniques are reviewed: open repair of an ulnar-sided triangular fibrocartilage complex tear, peripheral tear of the triangular fibrocartilage complex via arthroscopy, and the reconstruction of the distal radioulnar ligaments. The surgical interventions for arthritis discussed are the Sauve-Kapandji procedure, hemiresection arthroplasty of the distal ulna and distal ulna resection (Darrach procedure). The unstable distal ulna techniques are the flexor and extensor carpi ulnaris tenodesis stabilization of the resected ulna and the distal ulna implant arthroplasty. Lastly, the techniques to correct the ulnocarpal abutment are the arthroscopic and open 'Wafer' procedures and an ulnar shaft shortening osteotomy.

The largest section of the text discusses procedures related to the wrist joint. This section consists of 11 parts and reviews surgical procedures for the treatment of scaphoid fractures, scaphoid nonunions, nonunion of the hook of the hamate, scapholunate ligament injuries, carpal fractures and dislocations, ganglions, and the pediatric wrist. It also includes management of arthritis; particularly arthritis due to scapholunate advanced collapse and scaphoid nonunion advanced collapse, scaphotrapeziod arthritis, rheumatoid and post-traumatic arthritis, and Kienbock disease. Specific surgical techniques include percutaneous screw and pin fixations, open reduction and internal fixation with hardware and bone grafts, open repairs and reconstructions, tendon stabilization of unstable joints, carpectomies, arthroplasties, synovectomies, tendon transfers, fusions, and wrist denervation. The last section of the text discusses the carpometacarpal joint related to injuries and arthritis of the finger and thumb. Procedures discussed include ligament reconstruction, closed reduction and internal fixation of Bennett's or Rolando's fractures and dislocations, osteotomies, fusions, and arthrodesis of the ring and small joints.

Overall, the textbook provides a simple discussion of treatment options for a variety of diagnoses. This well-illustrated book allows the reader a simple understanding of the specific procedures used to correct wrist disorders. The discussion of postoperative care is limited to splinting and approximate timelines to begin therapy or limited use of the hand and wrist. There is not a discussion of rehabilitative procedures or references to rehabilitation in the suggested readings. This textbook would only be useful as a reference to the practitioner who evaluates and treats a significant number of clients with postoperative diagnoses of the wrist. It is a very easy textbook to read and presents the information well for any health care professional who is interested in the surgical techniques of the wrist.

Sylvia Mehl, PT, OCS

2007–2009 STRATEGIC PLAN

MISSION (what we are doing now)

To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

VISION (where we want to go)

The Orthopaedic Section will provide and support professional development for physical therapy clinicians as the preferred autonomous and evidence-based practitioners of choice for musculoskeletal care.

GOALS:

Evidence-based Practice
Enhance autonomous and evidence-based clinical practice for orthopaedic physical therapists.

Membership Services

Develop a process to understand and meet the needs of our members and continue to maintain growth in membership.

Professional Development

Facilitate professional development in orthopaedic physical therapy practice.

Practitioner of Choice

Educate and promote to the public that the orthopaedic physical therapist is the practitioner of choice for the management and prevention of musculoskeletal conditions.

Research

Provide leadership and support for performing and disseminating research and acquiring, appraising, and applying evidence for orthopaedic physical therapy.

Advocacy

Advance, promote, advocate for, and protect the practice of orthopaedic physical therapy.

GOALS, OBJECTIVES, AND STRATEGIES 2007-2009

1. Evidence-based Practice

Enhance autonomous and evidence-based clinical practice for orthopaedic physical therapists.

Objective A

Develop and maintain practice guidelines for common musculoskeletal conditions.

Strategy 1

Create, compile, edit and present ICF related practice guidelines for four common musculoskeletal conditions in 2007.

Strategy 2

Create, compile, edit and present ICF related practice guidelines for four common musculoskeletal conditions in 2008.

Strategy 3

Submit for publication eight established practice guidelines in special issue of the Journal of Orthopaedic and Sports Physical Therapy in 2009.

Objective B

Improve the ability of orthopaedic physical therapists to identify, critically appraise and apply the best evidence to enhance the diagnosis, management and prevention of musculoskeletal conditions.

Strategy 1

Beginning in 2007, solicit two articles per year for publication in *Orthopaedic Physical Therapy Practice* illustrating application of the process of evidence-based practice for the diagnosis, management and prevention of musculoskeletal conditions.

Strategy 2

Publish Independent Study Course on evidence-based practice and use of outcomes data to critically appraise clinical performance in 2009 to compliment orthopaedic residency and fellowship training.

Objective C

Enhance the autonomous diagnosis, management and prevention of movement-related disorders.

Strategy 1

Promote orthopaedic physical therapists for autonomous practice as defined by APTA through multiple media including Section webpage and Section sponsored programming and publications.

Strategy 2

Prepare orthopaedic physical therapists for autonomous practice as defined by APTA through multiple media including Section webpage and Section sponsored programming and publications (ongoing).

Strategy 3
Sponsor or co-sponsor joint programming with Private Practice Section at CSM in 2008 on transitioning Physical Therapists from employer/employee relationships to professional partnership models similar to those used by physicians, dentists and/or attorneys.

2. Membership Services

Develop a process to understand and meet the needs of our members and continue to maintain growth in membership.

Objective A
Understand and meet the needs of Orthopaedic Section members.

Strategy 1
Survey members through e-mail and Section web site annually or on as needed basis as determined by the Board of Directors and/or Membership Chair, to measure membership satisfaction, obtain suggestions, identify members willing to increase their involvement, and assess the best methods of communication with members.

Strategy 2
Develop a Section liaison network through which information can be collected and disseminated via e-mail blasts to a liaison of each chapter, who can present information at their annual state chapter conference, e-mail chapter members, and collect specific concerns and/or ideas from within membership.

Objective B
Demonstrate a positive growth in membership annually.

Strategy 1
Recruit new Section members who have entered the profession within the last 2 years to meet with students in PT/PTA programs to discuss the benefits of Section membership.

Strategy 2
Communicate the benefits of Orthopaedic Section membership via updates on web site and blast e-mails in conjunction with promotion of the ISCs.

Objective C
Promote diversity in Section membership actively recruiting minority members of the APTA to join the Section and to serve on the Section's Board of Directors, standing committees and task forces.

Objective D
To recruit and guide individuals willing to accept leadership positions within the Section.

Strategy 1
Maintain and develop an active pool of Section members willing to serve in a leadership positions through blast e-mails, surveys and/or personal communication.

Strategy 2
Committee chairs/member(s) will provide mentorship to individuals within the leadership pool.

3. Professional Development

Facilitate professional development in orthopaedic physical therapy practice.

Objective A
Provide the resources necessary to increase the number of orthopaedic residency programs.

Strategy 1
Develop programming to provide the didactic component for residency and fellowship programs that are not affiliated with an academic institution.

Strategy 2
Develop programming for residency and fellowship faculty on all aspects of residency and fellowship education.

Strategy 3
Facilitate partnerships between regional academic institutions and physical therapy facilities.

Objective B
Provide multi-level educational programming at annual or regional meetings.

Strategy 1
Develop criteria to define advanced educational programming for use at Orthopaedic Section meetings.

Strategy 2
Explore the feasibility of developing of new orthopaedic section programming or conference.

Objective D
Develop professional mentoring strategies for Orthopaedic Section membership.

Strategy 1
Provide resources that describe avenues to Section leadership roles, professionalism, as well as advanced clinical expertise in orthopaedic physical therapy.

Strategy 2
Develop ongoing collaboration with the Orthopaedic Specialty Council to provide a mechanism to communicate the needs and wishes of the Section with regard to specialization.

4. Practitioner of Choice

Educate and promote to the public that the orthopaedic physical therapist is the practitioner of choice for the management and prevention of musculoskeletal conditions.

Objective A
Promote Orthopaedic Physical Therapy.

Strategy 1
Facilitate membership participation in the APTA's "Find a PT" program through e-mail blasts and OPTP advertisements over a 6 month time frame.

Strategy 2
Form a task force to: (1) assess targeting strategies and developing media (ie, PDF brochure as example) that promotes orthopaedic physical therapists as the practitioners of choice for management and prevention to be used for the following target groups: members, prospective members, consumers, physicians, non-physicians, qualified providers, legislators, insurers and employers; (2) develop partnerships with APTA and other Sections on joint marketing strategies; and (3) investigate words or phrases that brand orthopaedic physical therapy to the public.

5. Research

Provide leadership and support for performing and disseminating research and acquiring, appraising, and applying evidence for orthopaedic physical therapy.

Objective A
Establish a network of mentors for research.

Strategy 1
Develop a relationship with the Research Section to create a network of mentors for orthopaedic research.

Objective B
Increase Orthopaedic Section Grant submissions by 10% yearly.

Strategy 1
Advertise the grant program in *JOSPT* .

Strategy 2
Advertise the grant program in *OPTP* .

Objective C
Support efforts of *JOSPT* to increase submission of research articles by 5% yearly.

Strategy 1
Provide mentorship to individuals considering publication in *JOSPT* by including a *JOSPT* representative in the Research Information Exchange roundtable at CSM.

Objective D
Provide information to members regarding sources of funding for research.

Strategy 1
Make a link on the Orthopaedic Section web site to the Section on Research, the Foundation for Physical Therapy, and other applicable web sites for funding sources.

Objective E
Translate evidence into practice .

Strategy 1
In every issue of *Orthopaedic Physical Therapy Practice*, there will be an article that integrates/ translates evidence into clinical practice, such as a critically appraised summary of an article from *JOSPT* that impacts clinical practice.

Objective F
Increase the amount of information regarding Research Committee activity to the membership.

Strategy 1
Increase information on the Orthopaedic Section web page.

6. Advocacy

Advance, promote, advocate for, and protect the practice of orthopaedic physical therapy.

Objective A
Promote the orthopaedic physical therapist as the practitioner of choice for the management and prevention of musculoskeletal conditions to regulatory agencies, legislators, and payors.

Strategy 1
The Orthopaedic Section will advocate for the practice of orthopaedic physical therapy on a national level.
A: Develop a national agenda.
B: Develop a specific orthopaedic section payor forum.
C: Explore options for a direct lobbying effort on Capitol Hill.

Strategy 2
Utilize APTA networks (i.e. government affairs, practice, and reimbursement) as resources for Orthopaedic Section members.

Strategy 3
Collaborate with APTA State Chapters to establish an orthopaedic practice network consisting of liaisons from the Orthopaedic Section to each Chapter.

Objective B
Advocate for appropriate reimbursement to the orthopaedic physical therapist.

Strategy 1
Develop strategies to enhance orthopaedic physical therapy reimbursement through the education of payors and consumers.

Strategy 2
Network with APTA and chapters to assist with reimbursement forums by offering speakers to present information relative to orthopaedic physical therapy practice.

Strategy 3
Develop educational programming at CSM and the orthopaedic conference for creating viable reimbursement strategies for our members.

Strategy 4
Develop ISCs to educate our membership in the creation of viable reimbursement strategies.

Strategy 5
Develop a coalition among APTA sections to advocate for appropriate reimbursement of physical therapy services.

Objective C
Attain legislative and regulatory protection of orthopaedic physical therapy practice.

Strategy 1: Support and collaborate with APTA's Referral for Profit Task Force.

Strategy 2: Develop a coalition with other Sections to work in collaboration to protect physical therapy practice from infringement by other providers.

Objective D
Identify alternative practice opportunities for members negatively impacted by referral for profit and infringement by other providers.

Strategy 1
Work in collaboration with APTA to identify and develop emerging practice opportunities.

Strategy 2
Provide CSM/Orthopaedic Section programming to our members regarding the potential of emerging practice opportunities.

Strategy 3
Provide a publication to our members regarding the potential of emerging practice opportunities.

grantsfunded

Projects funded for 2006-2007

The Orthopaedic Section, APTA, Inc. received 10 grant applications for their grant program in November, 2006. The grants were reviewed by an External Review Committee, and 3 grants were selected for funding. The projects funded for 2006-2007 funding cycle are:

1. Effects of proximal and distal tibiofibular joint manipulation on lower extremity muscle activation, ankle ROM, functional outcome scores in individuals with chronic ankle instability.
   Grant amount: $10,000
   Principal Investigator:
   James Beazell, PT, MS, OCS, FAAOMPT, ATC
   Co-Investigators:
   Eric Magrum, PT, OCS, FAAOMPT;
   Lindsay Drewes, MEd, ATC;
   Terry Grindstaff, PT, ATC;
   Jay Hertel, PhD, ATC, FACSM;
   Christopher Ingersoll, PhD, ATC, FACSM

2. Validation of a clinical prediction rule to identify patients with neck pain likely to benefit from thoracic spine thrust manipulation: a RCT.
   Grant amount: $9,500
   Principal Investigator:
   Josh Cleland, PhD, OCS, FAAOMPT
   Co-Investigator:
   Julie Whitman, PT, DSc, OCS, FAAOMPT;
   John Childs, PT, PhD, OCS, FAAOMPT

3. Measurement of median nerve conduction velocity before, during, and after repeated application of the ULTT in healthy adults and patients with complex regional pain syndrome Type I.
   Grant amount: $10,000
   Principal investigator:
   Nancy Quick, PT, PhD
   Co-Investigator:
   Sally McCormack, PT

USING REHABILITATION PSYCHOLOGY TO FACILITATE POSITIVE CHANGE AND OPTIMAL OUTCOMES

By William Griesmer, PT, BSJ

Working with clients recuperating from work injuries is a common occurrence for many physical therapists. In 2005, a published study by Gordon S. Smith determined an estimated 19.4 million medically treated injuries occurred annually to working-age adults from 1997-1999.[1]

It is also noted that following a low back injury, only 50% of the workers who have been off work for 6 months ever return to work, only 25% return to work after having been off work for 1 year, and a negligible percent return to work after having been off work for 2 years. In addition, research by J.P. Strang found the literature supports but does not necessarily prove the following propositions concerning clients receiving Workers' Compensation following a job-related injury.[2]

1. They are less likely to have an established diagnosis and objective findings.
2. They are more likely to attribute their complaints to an event or injury at work and be involved in litigation.
3. They have a higher prevalence of more severe psychological disturbances.
4. They are at greater risk for not responding well to surgical intervention, even when carefully selected, and are decreasingly likely to improve following subsequent procedures.
5. They are more resistant to conservative treatments.
6. They absorb greater medical and compensation costs.
7. They are less likely to return to work, especially if out of work more than 6 months with multiple surgical procedures or involved in litigation, unless strongly motivated to be productive again.
8. They are, if motivated, probably best treated with a coordinated multidisciplinary approach.

Thus, it is clear that work-related injuries are very frequent and can easily become very involved and complicated cases. From a professional, ethical, and financial perspective, a positive outcome is obviously desired and would provide many benefits for all involved parties. The rehabilitation provider is left to ask, "What can I do to facilitate a positive outcome in this scenario?" Using some principles and techniques of rehabilitation psychology can help ensure an optimal outcome. While some of the specific techniques in this article are more suited to working with clients in a clinical Work Conditioning/Hardening Program, many of the underlying principles can be applied to any physical therapy setting.

FROM THE START

Facilitating positive change begins early in the process, according to Dr. James Clark, a licensed psychologist with extensive experience working in a CARF Accredited Chronic Pain Management Program and providing Disability Counseling.[3] According to Dr. Clark, it is very important to determine early on what a client wants or expects. "The greater the gap between their expectations and reality, the stronger the emotional response will be. This is the key to determining how happy someone will be with a process or outcome."

Some sample questions a PT could ask in the first visit or early on in the process include:

- "How can I help you?"
- "What do you hope to accomplish?"
- "What do you expect will happen here?" or
- "In your own words, tell me what is wrong and what your goal is."

In sum, it is important to determine: what kind of recovery does the client expect? One hundred percent physical restoration? A return to full premorbidity? From a rehabilitation/medical perspective, is this feasible and realistic? A therapist has to be careful of making specific promises with specific time frames. Sometimes, it is likely there will be a long-term deficit or other impairment. If this is the case, it is better to be up front with that information, depending on each individual circumstance.

Some sample language that may be useful for this situation would be "I want to work with you so you can become as healthy and productive as possible. In order to accomplish this, I suggest the following. We'll complete a thorough evaluation and based on that information, we'll put together a treatment plan to help you accomplish that. Is this something you want to do?"

It is worth noting at this point that it may be difficult for many clients with work injuries to set expectations or accept possible deficits. There are many reasons for this. Clients may not fully understand their diagnosis, have little knowledge of the BWC system, be under financial stress and have poor understanding of other options with the same employer, other employers, or even other fields. From a client's perspective, they may know little more than their body hurts and they can no longer do their job, which can cause major stress for them with regards to finances, employment, and home life.

Depending on what stage of the rehabilitation process a client is in, a case manager may be assigned and may be able to provide assistance with nonmedical and employment issues. It can be very helpful to communicate with the case manager to help explain the situation and set forth a plan.

Once a client's expectations are reviewed, the next step is to translate these into goals. In an ideal situation, the client will come up with goals on their own, though many clients may require assistance. According to the New Client Evaluation Model, the emphasis is on a client's goals and what the client will or won't do to accomplish these goals. In doing so, the

therapist and the client together design and agree to a 'contract,' which lists what the therapist and the client will or won't do to accomplish these goals.

During this process, Dr. Clark advocates an approach called Motivational Interviewing (MI). MI, originally designed by Rollnick et al, is a treatment approach that seeks to help the client accomplish a personally relevant and meaningful goal by eliciting and amplifying the person's intrinsic motivation for change. There are 3 core components of MI:

1. MI is client-centered. The focus is on the concerns of the client and identifying the reasons for and advantages of change for the client. It is important to express empathy and genuine, nonconditional warmth.
2. MI is directive. It focuses on and reinforces positive behavior and action. Sometimes, this involves reframing, or seeing an action in a positive light. An example of this would be "Despite your pain and lack of sleep you made it here for treatment today!"
3. MI is a way of being with the client. It requires respect for client autonomy and freedom to choose their direction but also can involve explaining the consequences of decisions. "It's your choice. If you choose not to do this, I'll have to discharge you. It's not a threat. You have the right to do whatever you want to do."

PREPARING FOR CHANGE

At some point, the client will be faced with making a change. They may be asked to attend physical therapy sessions. They may be asked to perform exercises in the clinic or at home. They may be asked to perform different duties at work. They may not have a position to return to at work. They may have to consider a different job with the same employer or even a different job altogether.

Dr. Clark[3] notes a Three Factor Model of Change. This means that people change when there is a critical mass of some combination of 3 factors which must be present in every decision to change. If any one of these factors is missing entirely, it is very unlikely that any change will occur. These factors are:

1. Willingness. The goal is important to me.
2. Readiness. Now is a good time.
3. Ability. I believe I can do it.

Working through this process should help prepare transition into a therapy program. When it comes time to execute the specific physical therapy program, safety must be a top priority. According to Roy Matheson and Associates, "…the most limiting domain must be the psychophysical…Even with supposedly pure biomechanical or cardiovascular-metabolic procedures, the effort expended by the client (which is governed by the psychophysical domain) is the most limiting factor.[4]

As treatment continues, the therapist's role is to help the client stay on task with specific recommendations and support the treatment effort. Sometimes, the client may 'relapse' or revert to poor behavior. There can be a number of reasons for this. The client may lose trust in his doctor or therapist. The client may become very depressed. The client may come to believe they have not been diagnosed and therefore have an untreatable medical condition. Recovery can result in the loss of positive reinforcements (ie, loss of pain medications, etc.). Or recovery can lead to the start of an adverse situation (ie, a return to work).

There are 4 guiding principles of MI that are important to remember over the course of treatment.

a. Express empathy. It's important to listen with the intent to understand. "I understand you're still having pain."
b. Make note of discrepancies between core values/goals and present behavior. If there is a discrepancy, politely point this out to help move change forward. "We agreed at the start that we wanted to improve your strength, but you haven't done the exercise. What can we do to help get that done?"
c. Roll with resistance. Avoid direct opposition. A therapist wants to work with the client to accomplish goals. Take what you find helpful and leave the rest. "You got 10 repetitions done with no increase in pain? That's great!"
d. Support and build self-efficacy. The main point for the therapist to get across through both words and actions is, "I believe you can make these important changes that will hopefully improve your health."

At this point, the therapist comes full circle with the client to their original goals (which hopefully the client had a hand in designing). It is the therapist's role to help identify barriers or sources of ambivalence and help the client work through them. Again, it can be appropriate to ask the client, "Where do you want to go from here?" Try to focus attention on the client's successes.

In summary, treating clients with work injuries is a common and potentially difficult task for many physical therapists. It is important to work together to set goals and be upfront about likely outcomes. Motivational interviewing provides a means for helping clients work through barriers to achieve their goals, which can lead to a win-win outcome for all parties involved.

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Further information about Motivational Interviewing can be found in the book, *Health Behavior Change: A Guide for Practitioners* by Rollnick, et al. ISBN # 0443058504.

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PRESIDENTS' MESSAGE

Stephen G Paulseth, PT, DPT, SCS, ATC

Greetings to all fellow foot people! Another CSM has come and gone, just like a winter storm, which is what actually happened while in Boston. Our SIG Vice President, Dr. RobRoy Martin put together another excellent FASIG program on Ankle Instability that was well attended and received. We also offered a 2-day preconference course in collaboration with the Massachusetts state chapter involving Foot Classifications and a day on Manual Therapy Techniques for the Foot and Ankle.

The annual business meeting was well attended considering the difficulty encountered by those traveling to Boston in the winter. Thank you to those of you who joined us for food, beverages, and of course dialogue concerning the foot and ankle in any capacity. To those of you who are interested, the CSM business meeting minutes are available at our web page. We were to elect a President and Secretary/Treasurer, but due to the absence of our Nominating Committee this did not occur. Further, there was a surprising lack of nominees who were available for the executive positions in our SIG!?? I call upon all of you to get involved with the Foot and Ankle SIG. We always value new ideas and new faces and extend this invitation to you to run for a SIG position. Also, I encourage you to take the time to complete the membership survey located at the Foot and Ankle SIG page of the orthopt.org web site, especially if you treat foot and ankle injuries on a regular basis.

This year should be quite exciting as we plan for next year's CSM in Nashville and the third research retreat. If you have any treatment pearls or the like, please submit them to me so they can be shared in this publication. Remember to become active in our SIG and … "Who you know will get your foot into the door. What you know will keep your foot out of your mouth." (unknown author)

painmanagement

SPECIAL INTEREST GROUP

PRESIDENT'S MESSAGE

John E. Garzione, PT, DPT, DAAPM

Highs and Lows

Anyone who is acquainted with me knows that one passion I have is flying a small aircraft. In flight training, we are taught to look for high and low weather pressure areas, anticipate them, and to adjust the altimeter accordingly. The altimeter must be set to the current barometric pressure to get a fair idea of the altitude that the plane is flying. If the altimeter is set too high, then the plane is lower than the pilot thinks which leads to a sudden and unexpected contact with the ground. Memory aides are recited to remember what to do before something bad happens. ("High to low, look out below, etc.") The purpose of this type of training is to minimize high stress times in the cockpit to make every flight safe and fright free (at least for the pilot).

Clinical practice for the pain management physical therapist also goes through periods of highs and lows on a daily basis; however, our professional training does not truly prepare us for this. I say to my clinical students that "the highs and lows in pain management would make the roller coaster at Six Flags seem like a merry go round." Some patients who come to the clinic have been in significant pain for years, are depressed, weak, and angry. They have been to numerous medical doctors, therapists, and nontraditional practitioners (the low). They don't seem to have a snowballs chance in Hades for improvement and yet amazingly enough, they improve and return to successful functioning in society (the high). Then there are those who are not as involved or disabled (the high) try as hard as they can, and still show little functional improvement despite the heroics and latest evidence based treatments (the low).

The Pain Management Special Interest Group is dedicated to improve treatment of pain and to bring the latest theories and techniques to all of the members. We have had excellent educational programming at CSM, but I would like to embark on a new program of periodically sending blast emails to our members of interesting recent studies that have been published in other related journals. If you are not a member of the SIG, you can contact the Orthopaedic Section and request to be a member. There is no cost for this service.

Will this undertaking eliminate the highs and lows of clinical practice? No, but it will help give us more techniques to use on our more difficult patients and to anticipate the 'highs and lows' better.

A MEDICAL OPTION FOR PATIENTS WITH PERSISTENT SPINAL PAIN DUE TO THE FACET JOINT: RADIOFREQUENCY NEUROTOMY

Greg Dedrick, PT, ScD, COMT
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How many patients get better but not well? How often do patients have their range of motion and strength improved, yet the pain persists? What can physical therapists' and pain physicians offer these patients?

The facet joint is a common site of referred pain in the spinal regions.[1-4] In the lumbar spine, referred pain into the posterior buttock and trochanteric regions (L4-L5) or the groin (L2-L5) occurs with an irritating injection of the medial branch of dorsal ramus.[4] Studies by Dwyer and Aprill have reported wide areas of referred pain from the upper cervical region into the posterior occiput (C0-1 and C2-3 facets) with palm prints of referred pain with descending facet joints coursing to the interscapular region (C6-7 facet).[1,3] Dreyfuss performed an injection study investigating the thoracic facet joints and found a similar pain referral to that of the cervical spine with a wider degree of overlap (4-5 segments) through the entire thoracic spine.[2] The pain referral patterns are of little help in teasing out the pain generating structure since the invertebral disc can refer pain into similar regions.[5,6] This presents a diagnostic conundrum for the clinician.

Using our clinical skills and reasoning to rule out the disc as a source of pain will assist in decreasing the number of pain generating structures. According to Stankovic et al, flexion limitation with extension provocation is the greatest predictor of intervertebral disc pathology in the lumbar spine.[7] Using this range of motion outcome combined with neural testing (slump and straight leg raise testing) can assist in ruling out the intervertebral disc or dural structures. A study by Revel et al investigated patient characteristics associated with a positive response to facet injection. The patients receiving the best response were those who had at least 5 characteristics: (1) pain relieved with recumbency, (2) pain not increased with coughing, (3) pain not worse with forward flexion, (4) pain not worse with rising from forward flexion, and (5) pain not worse with hyperextension.[8] Using these criteria along with clinical reasoning, patient history, and examination findings, physical therapists can make recommendations for patients to seek a consultation with a pain physician to consider radiofrequency neurotomy of the medial branch of the dorsal ramus.

What evidence do we have to suggest positive outcomes using radiofrequency lesioning to reduce facet related pain? A systematic review by Boswell et al discusses the short and long term effectiveness of facet joint and medial branch nerve blocks and radiofrequency neurotomy to the cervical, thoracic, and lumbar spine. For intra-articular injections, the evidence is limited for both short- (<3 months) and long-term (> 3 months) pain relief in the cervical spine. There is moderate evidence to suggest intra-articular injection is successful in short- and long-term pain modulation in the lumbar spine. For medial branch nerve blocks, there is moderate evidence to support short- and long-term pain relief with repeated interventions. In regards to radiofrequency neurotomy, moderate evidence exists to suggest both short- and long-term pain relief in the cervical and lumbar spine while effectiveness for pain relief in the thoracic spine could not be determined.[9]

As with any medical procedure, proper patient selection is a key to success. Physical therapists can assist physicians with their patient selection and use this collegial relationship to benefit patient outcomes.

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CASE STUDY

Gail Apte, PT, ScD, OCS, COMT

Assistant Professor, ScD Program in Physical Therapy, School of Allied Health Sciences, Texas Tech University Health Science Center

HISTORY

Pt is a 14 yo girl, competitive swimmer. She has had bilateral upper trapezius/base of the neck pain for the past year. She swims 3 to 5 times a week during swim season and 2 to 3 times a week during the off season when she plays water polo.

She rates her pain as 6-8/10 after she has been swimming for ½ hour or longer. The pain is worst when swimming freestyle. She has minimal symptoms during other strokes. Her complaints consist of upper trapezius pain mainly described as an aching pain and midline pain at CTJ/upper thoracic that she describes as a more sharp pain.

Observation:

- She prefers sitting slouched stating her neck and arms feel better.
- Mild elevated 1st ribs right>left.
- R>L supraclavicular fossa fullness.

Basic Cervical Exam:

- Flexion: No limits but c/o pain/stretch on bilateral paraspinal areas. Pain intensifies to 3/10 at midline CTJ if she maintains the position for a few moments.
- All other motions are without limits and pain free.
- Median > Radial nerve tension tests reproduce some sensation of discomfort in the R>L arms.

Local Cervical Exam:

- Negative ALAR, TLA laxity tests
- Chin Tuck Ext (Retraction)>Protraction causes upper trap pain bilaterally 5/10
- Rotation R + SB R produces upper trapezius pain (base of neck) on the left 4/10
- Rotation L + SB L produces upper trapezius pain (base of neck) on the Right 4/10
- Addition of flexion and extension does not change pain to above findings
- SB R, Rot R and SB L, Rot L are not provocative
- C2-3 - 4-5 segmental side bending tests are hypomobile bilaterally

Rib Exam:

Cervical rotation lateral flexion test on the right reveals a limitation in motion with a hard end feel indicating an elevated first rib.[1-3] Position and spring test for ribs 2-10 reveals rib 2 is elevated into inspiration with a hard endfeel and quite painful (6-7/10).

CTJ Exam:

Retraction > Protraction causes upper trap pain bilaterally 5/10
Retraction + Rotation and Side Bend ipsilateral reproduce contralateral pain 6/10 bilaterally.
Mobility testing unremarkable
A: Multiple pain generators, multiple mobility dysfunctions:

1. CTJ discogenic possibly at C7-T1, T1-2 or as high as C6-7 because most pain is reproduced with retraction
2. Possible facet synovitis in lower cervical / CTJ
3. Clusters of limits C2-3 - 4-5 bilaterally
4. Elevated ribs 1, 2 bilaterally

Clinical Diagnoses:
1. Rib dysfunctions at ribs 1, 2 bilaterally
2. Cervico-thoracic discogenic pain

P:
1. Cervical/CTJ manual traction[13]
2. DV glides to CTJ
3. Treat clusters of limits in cervical spine
4. Rib mobilizations
5. Core stab and strengthening
6. Education re swimming strokes - avoid freestyle
7. Education re self management with mobilization and ex as above.

This young lady appears to have multiple pain generators and multiple segmental dysfunctions. Assessing the results of her examination in order of most provocative findings to least provocative findings reveals the greatest pain provocation to be with examination of the upper ribs and cervicothoroacic area followed by lower cervical spine. The first 2 ribs appear to be elevated and their position maintained in an inspiration position.[1-3]

It has been shown that sagittal plane motions are controlled by the disc whereas rotation movements are controlled by the Facet and capsule.[4,5,7,8] The facet capsule may be particularly provoked with 3-dimensional movements as with rotation, ipsilateral side-bending, and flexion for the lower cervical spine.[6] Addition of flexion during rotation and SB did not increase her symptoms. Such an increase would be expected considering the 3-dimensional coupling nature of the cervical spine. We can surmise that the location of pain generator is likely to be lower than the cervical spine. If this is the case, the most provocative test for symptoms on the right side would be when the facets are provoked with Protraction, rotation left and side bend left, thus maximally diverging the facet on the right. That is not the case with this patient. The pattern of pain does not match the biomechanics for facets in this area of the spine, thus it is possible that the pain produced is due to a disc irritation, particularly in the cervico-thoracic region.[9-12] Cluster of segmental limitations have been demonstrated by Jirout[7] in conjunction with hypermobility of an adjacent segment as may occur with disc pathology. Treatment with segmental mobilization can restore mobility to the affected areas of the spine, thus unloading the hypermobile segment which tends to be pain generating.

The patient demonstrates her swimming technique whereby she rotates her head towards both sides during breathing. Part of the time, her arm elevation is on the opposite side as her neck rotation. It has been shown that arm elevation causes ipsilateral thoracic rotation down to T6. It is possible that rotating her neck to the opposite side as the arm elevation creates an increased load of the cervical/cervico-thoracic disc segments, leading to an irritation of the disc as demonstrated by the location of pain and provocative movements.

This patient has received 4 treatments with good results. Her pain is currently 2-3/10 at its worst and 0-1/10 at best. She will continue to be seen to implement a stabilization program and to correct swimming mechanics.

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DEAR PASIG MEMBERSHIP!

Springing Forward!

The PASIG has begun planning and working on many of the projects we outlined in our previous Action Plan as well as at CSM 2007. We are looking for all members to get on board and join a committee and help us in our efforts to spring ahead. The Education Committee under the direction of Tara Jo Manal has already begun the planning for our CSM program and is pursuing the topic of the cervicothoracic region and how it pertains to dance and music medicine. The Research Committee headed by Shaw Bronner is also working on the citation blasts for 2007 and is in need of members to join, and submit a topic of interest for the PASIG membership. This Committee is also in need of members to step up and begin to pull that long awaited case study or project off of the back burner and begin to write it up. The Research Committee stands ready to help each of you in your efforts.

There is also room on the Scholarship Committee for student research, and the chair person, Leigh Roberts is in need of assistance with the advertisement of this scholarship and any other organizational tasks to keep this a viable project for CSM 2008. Erica Coffey and the Practice Committee continue to work with the PASIG and Dance USA on the emerging dance screen and is looking for help with the creation of a music screen for various musical performers. Finally, the Membership Committee, under the direction of Julie O'Connell is always in need of help to organize the membership, welcome newcomers, and make sure everyone is active and finding a place on a committee of their choice.

There are 2 very important elections this year for the office of President and Treasurer, as well as a Nominating Committee member. Please consider running for office, or contact Stephania Bell, Nominating Committee Chair for any ideas on members that might be interested in serving the PASIG as an officer. All of the committees need help and can use new and fresh ideas from the membership. The contact information for all of the chairs and executive board is listed in this newsletter and is also located on the website: www.orthopt.org.

Thank you again to all whom make this organization so dynamic and please make your new commitment to the PASIG and join us in making this SIG even better in 2007. Caring for the arts brings out the best in all of us!

Susan C. Clinton PT, MHS, OCS
PASIG President
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412-322-2494
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PASIG NOMINATING COMMITTEE: CALL FOR NOMINATIONS

Greetings to all PASIG members! Here is a chance for you to contribute to the ongoing growth and success of our group by running for office in 2007. You may nominate yourself or another PASIG member for office. Please see the attached position descriptions and feel free to contact any of the Nominating Committee members with questions and/or submissions. We look forward to receiving your nominations which are due by 5/31/07.

The following positions are open for nomination: President, Treasurer, and Nominating Committee member. Each position is for a 3-year term.

PASIG President

Duties:

- Serves as the official head of and public spokesperson for the PASIG.
- Presides over all meetings of the PASIG and the Executive Board.
- Is an ex-officio member of all committees except the Nominating Committee.
- Acts as a neutral member of the PASIG in voting matters.
- Exercises the right to vote to resolve a tie vote.
- Is liaison to the Orthopaedic Section.
- Attends the Orthopaedic Section Board of Directors meetings at CSM and the Fall Meeting (to be reviewed annually based on Section finances).

Additional Responsibilities:

- Appoints PASIG chairs and members of standing committees and, as necessary, appoints special committees.
- Directs PASIG-related correspondences to appropriate individuals within the SIG.
- Sends copies of appropriate PASIG-related correspondence to the Orthopaedic Section office.
- Compiles the agendas for all meetings.
- Provides for the orientation of all new officers and chairs.
- Attends the following meetings: PASIG Executive Board Meetings and conference calls, PASIG Annual Business Meeting at CSM.
- Submits progress reports and other pertinent materials to the Orthopaedic Section office by the deadlines specified in the Section calendar (e.g. submits the PASIG goals/objectives updates to the Section quarterly).
- Attends APTA meetings in which the President is required to represent the PASIG.
- Extracts relevant information from the minutes of the Orthopaedic Section and APTA meetings and distributes them to appropriate individuals.
- Responds to requests from the APTA and its components, sharing information with the Executive Board as indicated.

PASIG Treasurer Job Description

Duties:

- Assumes responsibility for submitting the PASIG budget by deadlines determined by the Orthopaedic Section each year.
- Assumes responsibility for the receipt, disbursement, and accurate recording of all PASIG funds.
- Presents a written financial report at the PASIG Annual Business Meeting and at Executive Board Meetings.

Additional Responsibilities:

- Serves as a voting member of the Executive Board.
- Serves as liaison to the Section Treasurer and Finance Committee.
- Distributes quarterly budget reports to the Executive Board via the Section office.
- Attends the following meetings: PASIG Executive Board Meetings and conference calls, PASIG Annual Business Meeting at CSM.
- Presents an updated budget proposal for the finance committee prior to deadlines determined by the Orthopaedic Section each year.
- Forwards copies of official correspondence to the President and to the Section's Program Coordinator.
- Maintains a copy of annual and quarterly budget reports for use in assisting the President in the orientation of the successor to the office of Treasurer.
- Other duties as assigned by the President.

Nominating Committee

Duties:

- Is responsible directly to the membership.
- The senior member of the Committee becomes its Chair.

Additional Responsibilities:

- Carries out or supervises the carrying out of the Policies and Procedures for elections via mail ballot and works with the Orthopaedic Section office on coordinating this project.
- Prepares a slate of candidates for each PASIG election that is submitted to the Executive Board four months prior to the CSM business meeting.

Guidelines: Nominees must be PASIG and Orthopaedic Section members. Nominees must give their consent to be nominated before their names are put forward. Nominees may be self-nominated. Upon agreeing to be nominated, nominees will be asked to write a short biography and a position statement regarding their ideas and role as an officer in the PASIG.

Please contact any of us with your nominations:

Stephania Bell, PT
Nominating Committee Chair
stephaniab@comcast.net

Sheyi Ojofeitimi, PT
Nominating Committee Member
sheyi.ojofeitimi@liu.edu

Heather Southwick,PT
Nominating Committee Member
hlsouthwick@comcast.net

Practice Committee

Are you interested in music? Does your patient population include musicians? The Performing Arts SIG is interested in developing a screening or assessment tool for musicians. Although there are currently multiple screening tools in use for professional and preprofessional dancers there is little out there for the large population of musicians.

If you are currently using a subjective or objective assessment tool for musicians, or are interested in helping to develop one please contact the PASIG

Practice Committee Chair, Erica Coffey via email at baumeb@upmc.edu.

Scholarship Committee /Student Research

ATTENTION STUDENTS
WOULD YOU LIKE $400 TO ATTEND CSM?

Then submit your performing arts related research or case study to CSM (abstract deadline is June 15, 2007). See www.apta.org for more information. Once your abstract has been accepted to CSM, then apply for the PASIG Research Scholarship by November 1, 2007. More details about the PASIG Student Scholarship can be found on our website http://www.orthopt.org/sig_pa.php. Contact Leigh A. Roberts, DPT, OCS with questions about the PASIG Student Scholarship.

If you are not sure how to prepare and submit an abstract for submission, PASIG Research Committee members will help you. Just contact Shaw Bronner, PT, PhD, OCS for assistance.

WE NEED YOUR HELP!!!!
COME JOIN US AND GIVE US YOUR INPUT!!!!
COMMITTEES FORMING NOW!!!!

EDUCATION COMMITTEE:
contact Tara Jo Manal at tarajo@udel.edu

PRACTICE COMMITTEE:
Contact Erica Baum Coffey at baumeb@upmc.edu

RESEARCH COMMITTEE:
Contact Shaw Bronner at sbronner@liu.edu

STUDENT SCHOLARSHIP COMMITTEE:
Contact Leigh Ann Roberts at lar@larpt.com

NOMINATING COMMITTEE:
Contact Stephania Bell at stephaniaB@comcast.net

MEMBERSHIP COMMITTEE:
Contact Julie O'Connell at juloconnell@aol.com

CHECK OUT THE ORTHO WEBSITE AT WWW.ORTHOPT.ORG!

PERFORMING ARTS SPECIAL INTEREST GROUP MEMBERSHIP FORM

To be a PASIG member, you must also be a member of the Orthopaedic Section. You may use this form for new membership, change of address, or updating your information.

Name: _____

Are you a: ❍ PT
❍ PTA
❍ Student

Prof. degrees/certifications: _____

Company name:_____

Address: _____

Phone:Fax: e-mail: _____

APTA member number: _____

Orthopedic Section Member: ❍ yes ❍ no

Years of experience treating performing artists: _____

What percent of your patient population are performing arts patients?

_____ Dancers _____ Gymnasts _____ Skaters

_____ Musicians _____ Vocalists _____ Circus Performers

Please list if you are affiliated with any performing arts schools, companies, or groups below:

_____

Do you have a website associated with your practice? ❍ Yes ❍ No

If yes, please provide the link: _____

Do you accept Student Affiliations? ❍ Yes ❍ No

If yes, what percentage of the affiliation is clinically related to the performing arts? 100%_____ or _____% performing arts and _____% research, regular orthopedics, neurology etc. Please describe: _____

_____

Please list any requirements for acceptance to the affiliation (ie. Orthopedic outpatient, final affiliation, interview, CV):

_____

Are you interested in serving as a mentor to other physical therapists or physical therapy students interested in the treatment of performing artists? ❍ Yes ❍ No

Are you interested in serving as a mentor to other physical therapists or physical therapy students interested in research related to the performing arts? ❍ Yes ❍ No

Are you interested in serving on any of the PASIG Committees?

❍ Practice
❍ Education
❍ Nominating
❍ Research
❍ Student Scholarship
❍ Membership/website

Can we list your name and contact information on the PASIG website, www.orthopt.org for a membership contact:

❍ Yes ❍ No

Thank you for taking time to complete this questionnaire. We look forward to having you as a member. Please return this form to the Orthopaedic Section or email the information to tfred@orthopt.org.

animalpt

SPECIAL INTEREST GROUP

EQUINE BACK PAIN

Laurie Edge-Hughes, BScPT, MAnSt (Animal Physio), CAFCI, CCRT

Part One: the potential causes of back pain in the horse

Poor performance (ie, difficulty in jumping or performing high-level dressage exercises), plus or minus lameness is a common problem for athletic horses.[1] Back pain may be the underling pathology in these animals.[2] Other manifestations might include rearing, bucking, progressive or sudden changes in temperament, resentment of grooming, saddling or mounting, and/or resistance to one or both hind legs being lifted for shoeing.[1] Clinical signs can include unilateral or bilateral hind limb lameness, shortened stride of the hind limbs, localized swelling over the affected portion of the back, and pain on back palpation.[3] A few etiologies have been identified as causal for equine back pain.

Fractures

Fractures have been reported to occur along the articular surfaces, through the dorsal spines, of the tuber sacrale, iliac wings or the sacrum or coccygeal vertebrae.[3,4] These are almost always caused by trauma such as falling over backwards after rearing.[4] Fractures involving the articular surfaces may result in neurologic (spinal cord) signs, where as fractures of the dorsal spines or pelvis are not likely to affect the spinal cord, but could involve nerve roots or peripheral nerves depending upon the location of the fracture.[4] Fractures of the vertebral body of the thoracic and first few lumbar vertebrae are rare in the equine but may result from a fall at high speed or collision with a stationary object. These tend to result in immediate onset of paralysis.[4] Ultrasonography or radiographs are most definitive in identifying fractures.

Impingement of Vertebral Processes

Impingement may be defined as the abnormal physical apposition/encroachment of two vertebral processes. It is characterized by malalignment and overriding of the spinous or transverse processes and may occur anywhere throughout the thoracic or lumbar spine, (excluding the lumbosacral junction) but is most common between T13 and T18.[5] Impingement of vertebral processes is reported to be the most common cause of equine back pain.[5] Aging is not a causal factor in its development, nor is excessive dorsoventral movement or being ridden under saddle.[5] Overlapping of the transverse or spinous processes have been seen in horses without impingement.[5]

Ligamentous Lesions

Lesions involving spinal ligaments may include dorsal sacroiliac desmitis, supraspinous ligament desmitis, or supraspinous ligament cyst and may account for 13% to 18% of all soft tissue injuries in young elite athletic horses.[3] Core lesions with a loss of parallel fiber pattern and a loss of normal echogenicity was actually seen on ultrasonography in dorsal sacroiliac ligaments.[3] These same finding can be identified in the supraspinous ligament as well.[3] One report of a cyst in the supraspinous ligament has been made.[3] It has been postulated that jumpers may be at particularly high risk for back injury.[3] Diagnostic ultrasound is of particular use in evaluating ligamentous lesion in the equine back, as radiography does not show ligament lesions and nuclear scintigraphy may not definitively discriminate between approximating soft tissue and osseous pathologies.

Degenerative Joint Disease

Degenerative joint disease (DJD) can affect articular processes, intertransverse joints, the sacroiliac joints, and intervertebral discs.[5] Degenerative joint disease is characterized by any or a progression of or through the following: lipping of the articular surface, cortical buttressing, indentation of the articular surface, osteophytes, periarticular and intra-articular erosions, spondylosis, and ankylosis.[5] Some degree of degenerative changes were seen in all specimens in a study of 36 euthanized Thoroughbred race track horses.[6] Degenerative changes were only correlated with age in regards to the sacroiliac joint, while the DJD of the vertebral joints was not a consistent finding in the older horse.[6]

Enthesophytes

Enthesophytes are osseous lesions of the muscular or tendinous attachment to bone.[7] They have been documented to have occurred at the tuber sacrale, on the dorsomedial, medial, ventromedial, and ventral surfaces of the sacrum as well as the dorsal, ventromedial, and medial surfaces of the ilium.[3,5] They also have occurred at the articular processes of the thoracolumbar vertebra, the dorsal spinous process, the insertion sites of the paraspinal muscles, the tubercle for the psoas minor muscle, cranioventral ischial tuberosity, dorsocranial margin of the obturator foramen, and the origin of the deep gluteal muscle.[3,5] On ultrasonography, enthesophytes can be diagnosed when abnormal cortical contour without discontinuity is visualized.[3]

Sacroiliac Joint Subluxation

In one study, presumed sacroiliac joint (SIJ) subluxation has been diagnostically linked to tuber sacrale height asymmetry.[3] However, in this same study tuber sacrale height asymmetry was always accompanied by desmitis of the dorsal sacroiliac ligament. Asymmetry of the tuber sacrale is thought to be an incidental finding of no clinical relevance and has not been verified as a clinical condition.[8] As well, in the post-mortem study of 36 racehorses conducted by Haussler et al, there was no evidence of joint subluxation.[6] So, according to the literature one should think of SIJ problems as either being degenerative joint

disease or ligamentous lesions (including desmitis and enthesophytes).[3,6,9] It would seem that sacroiliac joint subluxation is a misnomer and so sacroiliac joint pain should be replaced by a more generic title such as 'lesion of the sacroiliac joint' or 'dysfunction of the sacroiliac joint' that would better include actual pathologies that do occur at this joint.

Conclusions

It is interesting to note, that outside of fractures, the other reported causes of equine back pain are secondary in nature or the end result of a primary lesion or pathology. For example, an enthesophyte, ligament desmitis, or degenerative joint disease would be secondary pathologies following a biomechanical stimulus, or an overuse, over stretch, or traumatic injury and associated inflammatory reaction.[5] Impingements are hypothesized to be associated with localized overlap or malalignment of vertebral process which may have occurred as a developmental or acquired deformation that may be related to asymmetric ligamentous or musculotendinous forces that induce osseous remodeling and subsequent deviation.[5] Based on this rationale, further studies need to be conducted to better observe or identify (and address) acute injuries or dysfunctions before they become these chronic manifestations.

Part Two: Etiopathogenesis, clinical presentation and physiotherapy approach to dysfunctions of the sacroiliac joint in the horse

Sacroiliac joint (SIJ) pain in the horse has been previously both misdiagnosed and/or underdiagnosed.[10] It requires accurate diagnosis of a SIJ injury in order for treatment to be effective.[9] This paper will identify the clinical findings and etiology associated with sacroiliac joint pain and present a physiotherapy rationale for treatment.

Pathology

While a common term, SIJ subluxation has not actually been a verified occurrence in research literature for the horse.[6] Osteoarthritis, desmitis of the dorsal sacroiliac ligament, and SIJ enthesophytes on the other hand, have been found to occur.[9] One post mortem study revealed lesions confined to the SIJ such as increases in joint surface area or irregular outline associated with joint extension on the caudomedial aspect.[11] The joint extensions have been interpreted as chronic instability of the joint that necessitated joint remodeling and are not found in normal horses.[11] Another post-mortem study revealed degenerative changes of the sacral and ilial articular surfaces, with presence of lipping of the articular surface, cortical buttressing, indentation of the articular surface, osteophytes, and intra-articular erosions.[6] This same study also detected bilateral enthesophytes near the sacroiliac joint. Unfortunately this study did not use other diagnostic tools (imaging or clinical) and so, one cannot presume that these findings correlate with SIJ pain in vivo.

Dorsal sacroiliac joint desmitis has been identified on ultrasonography and correlated with asymmetry of the tuber sacrale in horses.[3] Enthesophytes, and fractures of the tuber sacrale were also identified as SIJ regional pathologies.[3]

Fractures may be the result of an acute trauma where the history of injury can be pinpointed. Cause and effect for sacroiliac joint osteoarthritis, enthesophytes, and desmitis are not so clear. Speculation has been made that overuse injuries can result in joint remodeling and that enlargement of the joint surfaces may occur because of the shearing forces and prolonged mild instability through the equine SIJ.[11] For the same rationale, enthesophytes and desmitis could occur.

Characteristics of Horses with SIJ Pain

A handful of studies have attempted to identify subjective history, clinical signs, and typical characteristics belonging to horses that have been found to have sacroiliac joint pain. The usual history for this population of horses, is that of poor performance or unwillingness to work.[10,11] Riders or trains may complain of a lack of hindlimb power, loss of movement, difficulty in working on the bit, difficulty in lateral movements, or refusing jumps.[10,11] Lameness may or may not be associated with SIJ pain, and some horses may additionally exhibit thoracolumbar pain.[10,11] One study found a greater preponderance of older, taller heavier Warmblood horses, followed by Thoroughbred or Thoroughbred cross horses that were used for dressage or show jumping while eventing, general purpose, or low level competition horses made up the rest of the population.[10]

Diagnostics

Clinical diagnostic findings may incorporate visual asymmetry of the pelvis, (especially in regards to relative position of the tuber coxae), gluteal atrophy, and a strong pain response or again asymmetry but without presence of gluteal atrophy and only a moderate pain response on gluteal palpation.[12] Shear tests or pain provocation tests have been described for SIJ lesions and utilize manual shearing of the ilium relative to the sacrum to assess pain produced with the maneuvers or evaluate the quality of movement produced.[1,5] Lameness, plaiting, moving close behind or wide behind, problems crossing over with hindlimbs when circling and an inability to walk back symmetrically have all been gait abnormalities found in horses with SIJ pain.[5,10]

Diagnostic imaging includes nuclear scintigraphy, radiography, periarticular injections of anaesthetic solution, and infrared thermography. Nuclear scintigraphy findings in normal horses show a high degree of symmetry from right to left at the SIJ and tuber sacrale regions, where as scinigraphic images of horses with SIJ disease show asymmetric uptake of radiopharmaceutical activity.[10,13] However, scintigraphic evaluation of the sacroiliac region should be combined with other clinical signs to support the diagnosis of SIJ pain because of the possibility of overlap in the range of radiopharmaceutical uptake between those with presumed SIJ disease and both normal horses and horses with other causes of lameness.[14] As well, while scintigraphy demonstrates increased bone metabolism, it cannot accurately determine the underlying pathology and may not be of value in soft tissue injuries.[15]

Ultrasonography is a sensitive imaging modality to assess the dorsal and lateral portions of the dorsal sacroiliac ligament and ventral sacroiliac ligament and their bony attachments.[16] It has been useful in detecting abnormalities such as ligament size which differs significantly from normal ranges in horses with ligamentous SIJ lesions.[15] In horses with a chronic history of

lameness, Tomlinson et al found they had a shortened dorsal sacroiliac joint ligament that was smaller than normal horses and smaller than on the contralateral side.[15] Acute lamenesses attributable to the SIJ region in horses showed a larger than normal increase in cross sectional area and a decrease in echogenicity of the dorsal sacroiliac ligament (suggestive of acute fibre tearing) and compatible with a diagnosis of acute desmitis.[15] Sonographic information must be interpreted in light of a thorough physical and lameness exam, SIJ stress tests, periarticular SIJ analgesia, and nuclear scintigraphy in order to differentiate between SIJ disease and SI ligament desmitis.[16]

Periarticular SIJ analgesia has been described as a diagnostic technique to detect soft tissue lesions of the SIJ.[5] However, in a clinical study of 74 horses with SIJ region pain, only 46% of the animals showed a response to this technique, where as nuclear scintigraphy identified 99% of the SIJ painful animals.[10] Hence, periarticular SIJ analgesia may be of limited diagnostic value in these cases.

Radiography of this region in the horse can be described as difficult at best, given ilial wing overlap and the deep anatomical location of the sacroiliac joint.[5] Primary indications for radiography may include acute or severe pelvic asymmetries, upper hindlimb lameness and pelvic crepitus or fractures.[5] Radiographic findings in chronic SIJ lesions may not be significantly different from those of normal horses.[11] Degenerative joint disease of cartilage may be present in both normal and SIJ problematic horses and the presumed presence of what can look like bone spurs are likely joint extensions.[11] Joint extensions, while still indicative of a pathology are not resultant from the same pathology as bone spurs. This leaves radiography as a nothing more than a speculative test.

Infrared thermography may be useful in identifying protective muscle spasms in musculature adjacent to the SIJ and palpation of muscle sensitivity has been correlated with abnormal thermographic images in most horses.[5] However, this test may not be specific enough to truly identify the SIJ as a source of pain.

Physiotherapy Treatment

In humans, treatment of the sacroiliac joint encompasses 'Form Closure' (aimed at restoring mobility and correction of osseous alignment), 'Force Closure' (addressing muscular strengthening or lengthening in order to stabilize the joint or reduce abnormal forces or pulls on the pelvis), and Retraining of Motor Control within the region (in order to re-establish normal patterns of movement required for locomotion as well as stabilization).[16]

Form closure

The shear tests can also be used as treatment techniques in the horse and can incorporate unilateral rotational shears, oblique shears, and translatory shears. The tests are then turned into mobilizations and can be graded according to Maitland's Mobilization Scale.[18]

Force closure

Strengthening of the gluteal muscles specifically may be accomplished by hill walking (especially up steep hills and zig zag down hill), hip abduction (turning in tight circles), and/or jumping over small jumps.

Flexibility will include stretching of the erector spinae (using the rounding reflex or taking carrots/crunchies under the chest), gluteals (hip flexion), hamstrings (hip flexion with stifle extension), sartorius (hip extension with some stifle flexion), iliopsoas (hip extension), adductors (abduction), and/or latissimus dorsi (shoulder extension stretches).

Motor control and timing

This can be accomplished with static balancing (3 leg standing) by lifting the unaffected hind limb off the ground and making the animal balance for 15 seconds or up to 2 minutes. Incorporation of muscle facilitation techniques can be used (ie, tapping on the muscles, neuromuscular electrical stimulation, hand positioning, manual cues, or proprioceptive taping techniques) to problematic muscles (ie, gluteals, latissimus dorsi, transverse abdominus, lumbar multifidus) and/or the pelvic floor (ie, using the pudendal reflex). Another technique might be crossed-leg standing (lifting the unaffected hind limb with a helper lifting the opposite front limb) with balancing for 15 seconds or longer as able. Alternately, the therapist could lift the contralateral front limb and direct a gentle diagonal force towards the affected limb to facilitate gluteal muscle contractions. Use of the gluteal rounding reflex or abdominal lifting reflexes could also exercise key muscle groups necessary for motor control. Simple backing up exercises could also be utilized.

Additional therapeutics

Advanced proprioceptive retraining could utilize the same balancing techniques as listed above but done on an unstable surface (ie, a large wobble board, camping foam or a natural uneven or spongy surface). *Endurance retraining* is best accomplished by performing repetitions. *Ballistic movement retraining* might include slow retraining of fast stops and starts, short bursts of sprinting, quick turns, small jumps, or mock barrel race training. *Global hypertonicity or rigidity* can be addressed by stretches, myofascial holds, trigger point releases, or 'Gunn' intramuscular stimulation. Complete SIJ retraining in a human would also sometimes incorporate breath retraining, self muscle-releasing techniques and self monitoring, all of which are not particularly trainable in a horse.

Equine specific therapies

Given the research findings of SIJ osteoarthritis and desmitis, one could attempt to incorporate treatments that target these pathologies specifically. Desmitis of the ligaments may respond favorably to eccentric loading just as tendinopathies of the patellar tendon or Achilles tendon in humans do.[19] Trotting work may accomplish this goal. Stretching has been shown to increase collagen synthesis and improve collagen fibre alignment, resulting in higher tensile strength.[20] Therapeutic modalities may be useful with SIJ lesions. Therapeutic ultrasound, pulsed electromagnetic field, and low level laser therapy have been shown to increase collagen synthesis in fibroblasts, thereby increasing tensile strength.[20,21] They may be useful in SIJ ligamentous lesions as well.

Osteoarthritis of the SIJ, if known to exist, can be treated with physiotherapeutic techniques as well. Strengthening supporting muscles will aid in shock absorption and an increase in strength and general conditions can minimize fatigue related injuries.[22] Both aerobic and strengthening exercises have been shown to reduce pain and disability, and are capable of increasing joint ROM and improving function.[23-25] Moderate exercise has also been shown to improve knee cartilage glycosaminoglycan content in humans at risk of developing osteoarthritis.[24] As well, stretching and mobilizations (as described above) have all been shown to aid in the treatment of osteoarthritis.[26,27] Modalities such as laser and pulsed electromagnetic field have been found to stimulate cartilage regeneration and slow the progression of O/A lesions.[28-32]

SUMMARY

In conclusion, physiotherapists can provide a wealth of benefit to the horse suffering from a sacroiliac joint lesion. Techniques based on human protocols for treating sacroiliac joint pain in conjunctions with targeted therapies for desmitis and/or osteoarthritis should be incorporated into standard care for equine SIJ lesions.

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